Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NOVEMBER, 1949

TABLE OF CONTENTS, Page 51

TECHNOLOGY DEPT.

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DETROIT

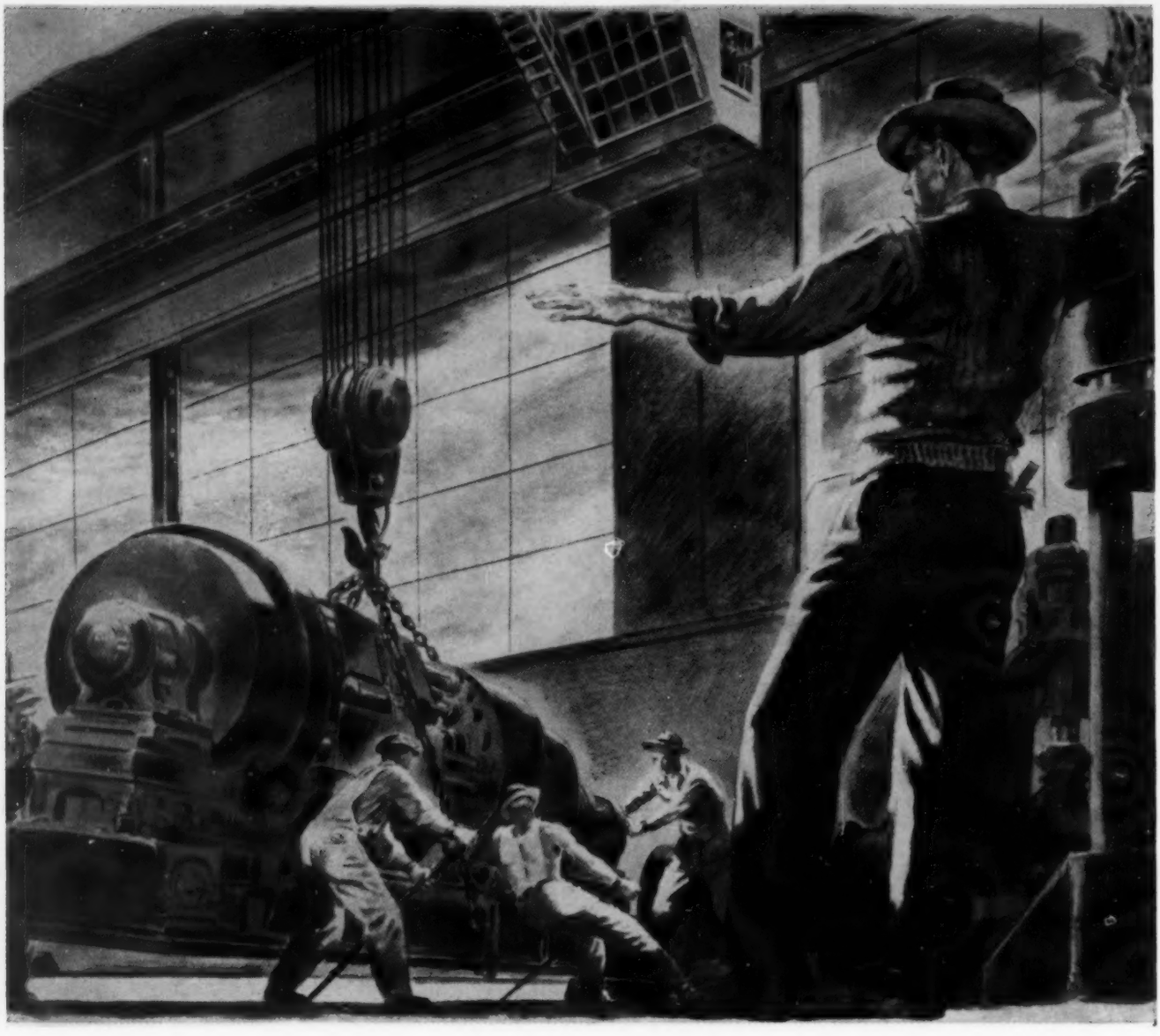
They started out together in 1932 at the Inland Steel Company, Indiana Harbor Works, East Chicago, Indiana. That was more than 17 years ago. They are still together today; still rolling steel with the same speed, efficiency and dependability.

The bearing has a total of 6,154,648 tons to its credit. A recent inspection indicated that it is good for many thousands more.

This is an old-style Timken roll neck bearing, 28½" x 46½" x 22½". For a similar job today we probably would specify a Timken Balanced Proportion bearing 32½" x 46" x 33¼". This would permit the use of larger, stronger roll necks and much greater bearing capacity.

THE TIMKEN ROLLER BEARING COMPANY
CANTON 6, OHIO
Cable Address "TIMROSCO"

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
ROLL NECK BEARINGS



The Crane Hoist Control that gives you "Dc Performance" on *Alternating Current*

Because it has not been possible in the past to get satisfactory crane hoist performance on alternating current, factories have had to install direct current generators or put up with other compromise solutions.

Today, that is no longer true. For now, Cutler-Hammer control engineers have come up with the long-sought solution to this troublesome problem. Today, you can get 5 safe, stable crane hoist lowering speeds, inching and dynamic braking . . . *on* alternating current, *with* standard slip ring motors . . . *without* mechanical load brakes, *without* supplementary control equipment, *without* costly maintenance. Today, you can get "Dc performance" on alternating current simply by specifying Cutler-Hammer bulletin 14164 Ac Crane Control *and nothing else*. Available in manual drum and magnetic types. Try it and see the difference. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.

Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER·HAMMER
MOTOR CONTROL
C·H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 26, No 11.

CONTINUOUS STRIP GALVANIZING

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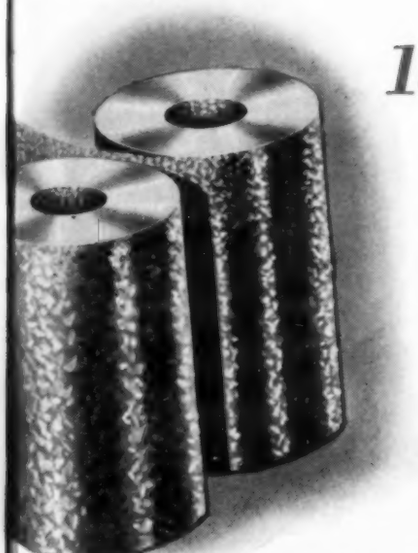


13 YEARS' EXPERIENCE
at your service . . .

●*This message is addressed to the executive who has been weighing the question of continuous strip galvanizing . . . the advantages, the cost figures, the profit factor, etc.*

Although the process, in heavy coils, is considered quite new, Aetna-Standard has 13 years of experience at hand. In those years our engineers have collaborated with Armco, Carnegie-Illinois, Tennessee Coal, Iron and Railroad and others in the development and building of continuous lines.

With this experience, you can have facts and figures for reaching a sound decision as concerns your company. Write to Aetna-Standard and we will arrange for our strip specialists to confer with you.

THE AETNA-STANDARD ENGINEERING COMPANY • YOUNGSTOWN, OHIO

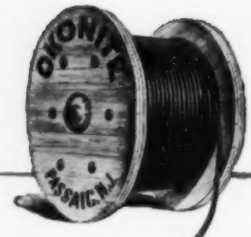
ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND

AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA

ONLY COMPLETELY-PROTECTED CONDUCTORS ASSURE *Longest-Lived* WIRES AND CABLES

. . . and only Okolite-Okoprene cables possess these 9 "factors of protection"



With today's installation costs* only the *Longest-Lived* will be economical

* The life-time cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.

❶ Conductors are coated with corrosion-resistant Okoloy, a lead alloy that outlasts tinning 2 to 1.

❷ Internal corona cutting is eliminated and dielectric strength increased by Semicon Tape applied over the conductor on all Okolite-Okoprene cables operating at over 2000 volts.

❸ Moisture-resisting, high-voltage Okolite, an oil-base insulation proved in over 20 years of service, is made with Up-River Fine Para, the best grade of natural rubber. Approved as Type RWSN by Underwriters' Laboratories.

❹ The Okoprene covering, a pioneering development of the Okonite laboratories, has established its stability and permanence on millions of feet of cable installed since 1935 under the most severe conditions.

❺ Both insulation and jacket are applied together in a single operation by the strip-process and uniformly vulcanized in a continuous metal mold to give the best and most dependable bond.

❻ Insulation and covering receive but a single vulcanizing "cure" thus eliminating the life-shortening effects of double vulcanization.

❼ Thickness of both insulation and jacket are accurately controlled by the Okonite strip-insulating process.

❽ In addition to a. c. tests, every Okolite-Okoprene cable is subjected to high-voltage d. c. tests more severe than used by any other cable manufacturer.

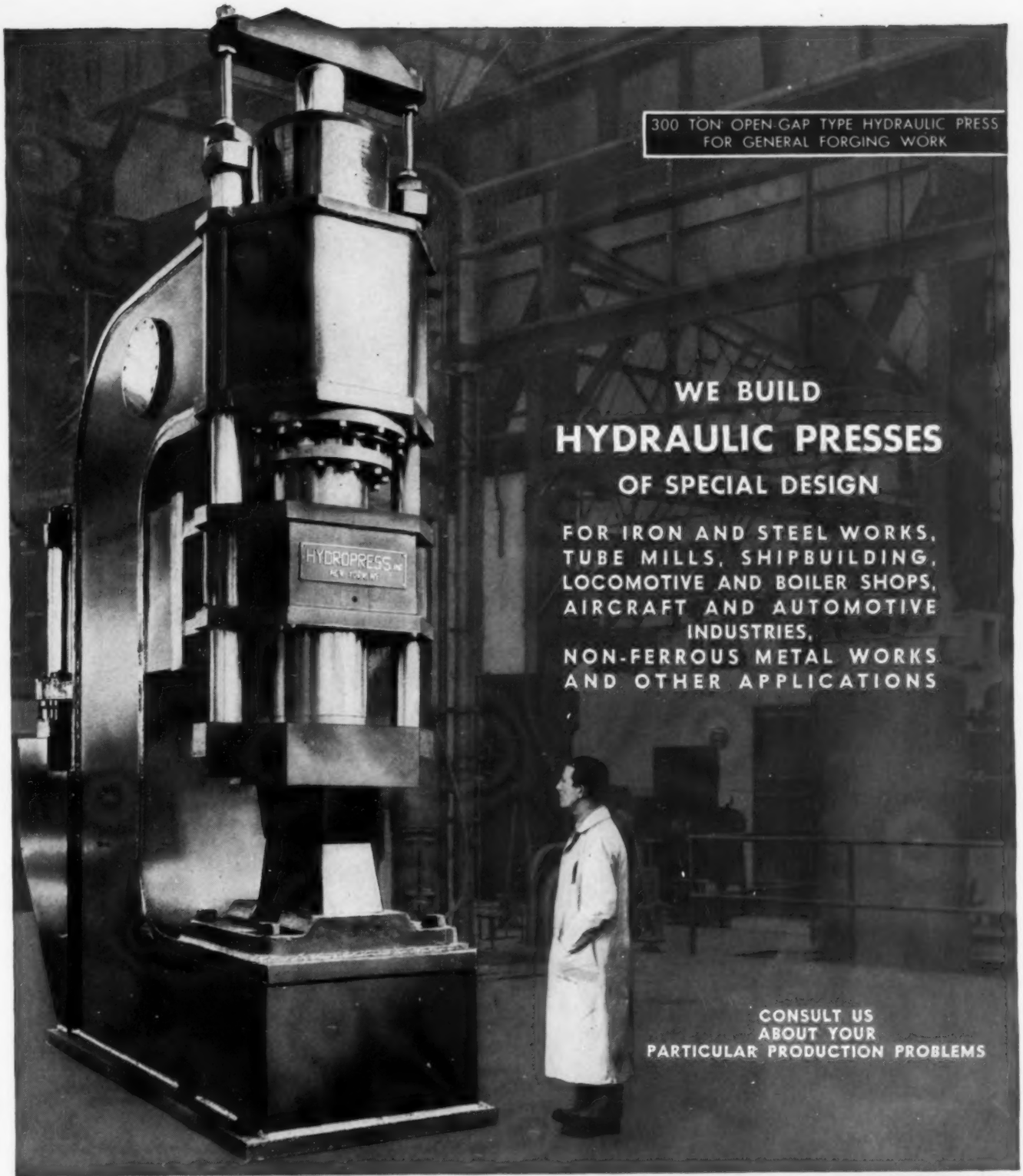
❾ Okolite-Okoprene cables have the longest and most extensive service record.

Okolite-Okoprene's electrical operating advantages, installation advantages and design advantages are given along with dimensional data in illustrated, information-crammed Bulletin IS-1037. For a copy, please address The Okonite Company. Passaic, New Jersey.

6627

OKONITE SINCE 1878 **insulated wires and cables**

THE BEST CABLE IS YOUR BEST POLICY



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ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ACCUMULATORS · PUMPS

ROLLING MILLS

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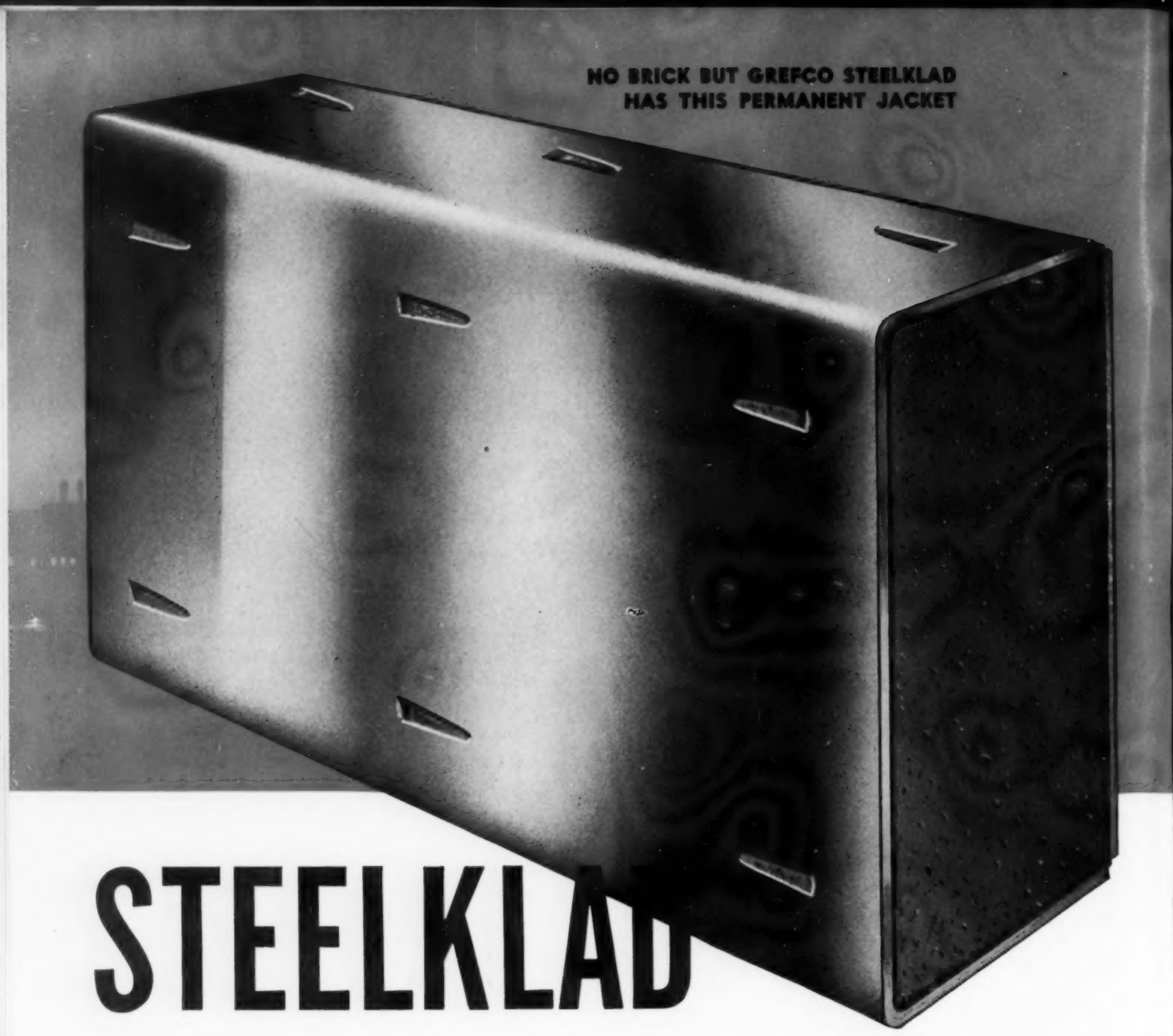


STEELKLAD

OUTLASTS ALL OTHER BRICK IN OPEN

Made by the RITEX process, using a special magnesite-chrome mixture, and jacketed under high pressure in a patented steel shell that is permanently locked to all four sides, STEELKLAD brick have repeatedly proven that they outlast all other brick, silica or basic, in open hearth furnace walls.

In several open hearth shops STEELKLAD front walls — which take the severest punishment in the furnace — have lasted entire campaigns *without a single repair*. This is an outstanding performance, and the money and time saved on repairs to these furnaces have been substantial.

A Complete Refractories Service

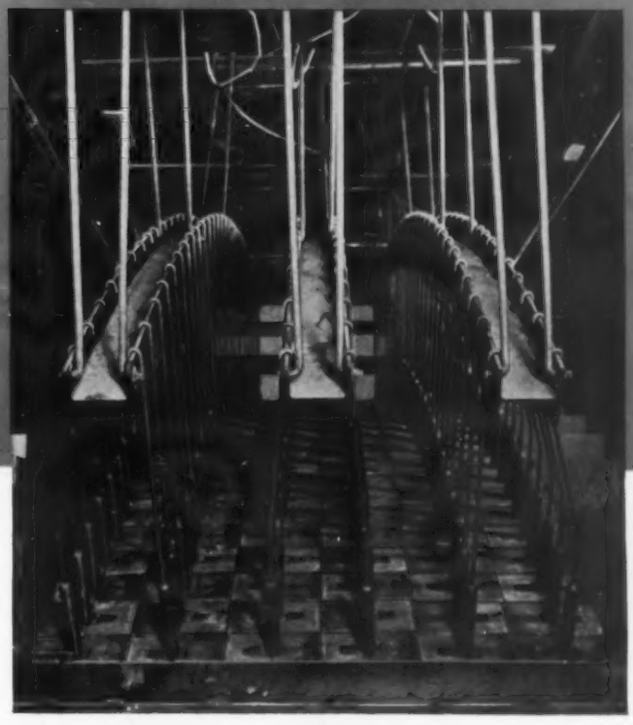
GREFCO

FOR EVEN GREATER SAVINGS— ALL-BASIC CONSTRUCTION

Suspended basic ends offer open hearth operators still greater savings. These savings are not theoretical — they have been proved. For further information about "Basic Ends and All-Basic Open Hearth Furnaces" write for your copy of the booklet of that title.

FERROCLIP brick, designed for suspended main roof, wall and arch construction, have an exclusive socket design that gives the greatest length of usable refractory obtainable in a supported structure. This socket insures maximum life of hangers and steelwork by keeping them cooler than possible with any other design. Grefco's radial suspension method provides a smooth inner surface without protruding corners or edges — thus assuring maximum life and efficiency.

Grefco Ferroclip Brick showing socket design



Radial suspension system for Ferroclip brick arches

STEELKLAD brick have proven themselves also in the basic sections of soaking pits where they show the same sort of efficiency that is characteristic of their open hearth performance. In a recent soaking pit installation STEELKLAD brick have lasted TWICE AS LONG AS ANY OTHER BRICK EVER USED.

HEARTH FURNACES

STEELKLAD back walls and ends have given similar service. Actual cost figures show that in only 1800 heats STEELKLAD basic ends saved many thousands of dollars in repair costs and 17 days of repair time in a single furnace. Compared with silica ends, in 1800 heats STEELKLAD brick saved 15 cents per ton of steel on end maintenance alone!

STEELKLAD brick used in front and end walls of open hearth furnace

GENERAL REFRACTORIES COMPANY

PHILADELPHIA, PENNSYLVANIA

Lubrication Dan sez . . .

"LEADOLENE is successful because it has nearly 75 years of experience back of it"

LEADOLENE *hydraulic oils*

dependably lubricate valves • prevent gum and corrosion under all climatic or water conditions

Brooks LEADOLENE* . . . the lubricant with the Indestructible pH-ilm . . . is carefully compounded to provide maximum lubricating efficiency and long service in hydraulic systems. Products of exhaustive laboratory research and control, LEADOLENE Hydraulic Oils vastly reduce the cost of replacement parts and increase production through the reduction of down time. Because of its extremely low pour point, LEADOLENE assures free operation with minimum power requirements . . . even in sub-zero weather.

Lubrication Dan knows of many applications in which LEADOLENE Hydraulic Oils are setting outstanding efficiency and economy records. The example of one large forging press is typical. Due to gum and corrosion, the horizontal plunger pump wore so badly it had to be returned to the factory for repairs every six months . . . at a cost of $1,320 each time. Since LEADOLENE was substituted as the hydraulic fluid, the pump has been in operation for over two years without repairs.

May we send more detailed information on how Brooks LEADOLENE can improve the efficiency of your hydraulic systems?

*LEADOLENE . . . the "I. P. Lubricant" (Indestructible pH-ilm) . . . for Industrial Needs

The Brooks Oil Co.

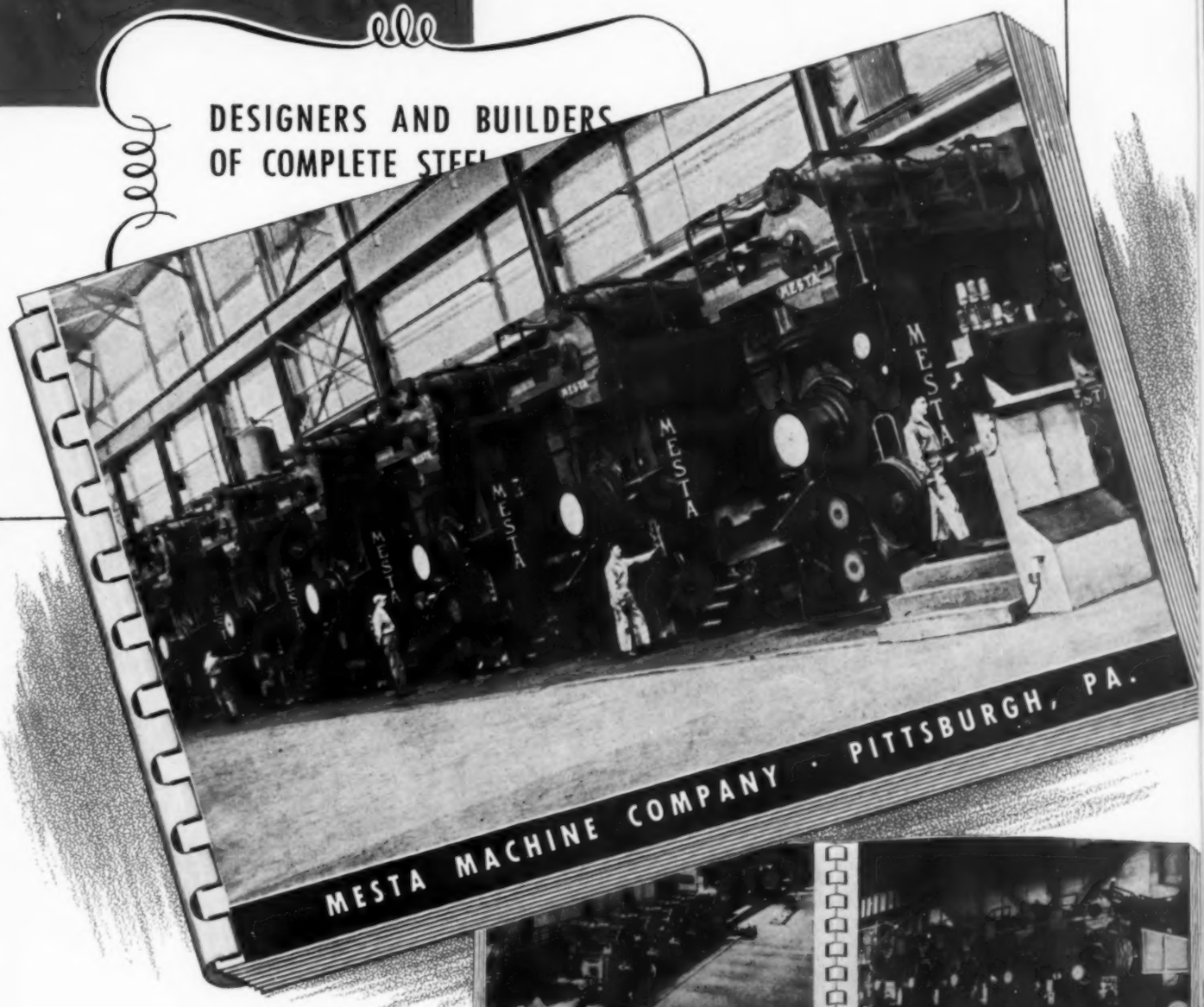
Pittsburgh 12, Pennsylvania
Cleveland, Ohio
Hamilton, Ontario

Warehouses in Principal Industrial Cities

MESTA

PLANT and PRODUCT

DESIGNERS AND BUILDERS
OF COMPLETE STEEL

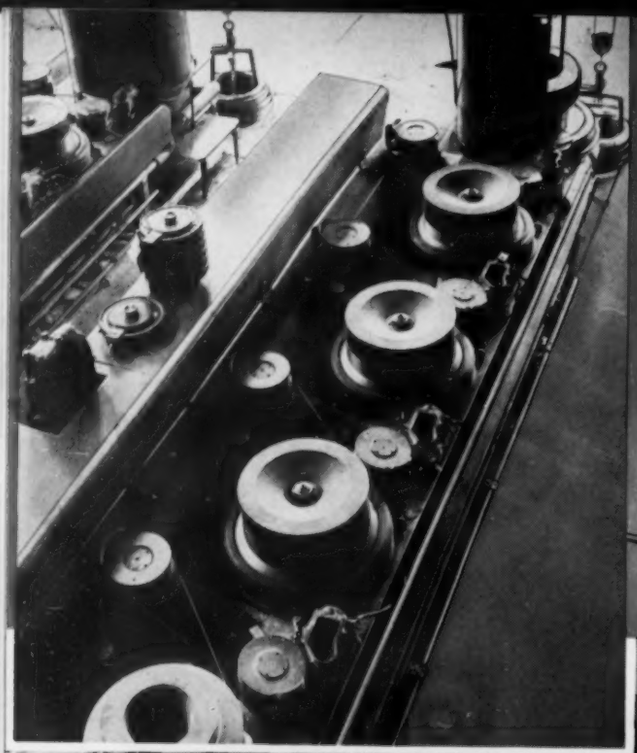


Write for Your Copy

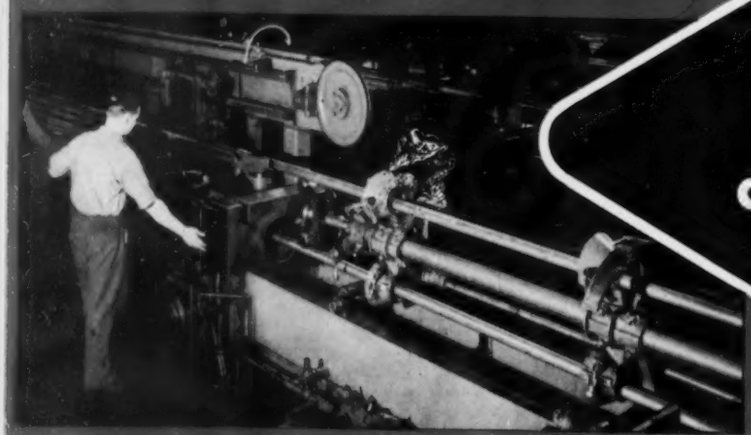
Views in the Mesta plant, together with installation photographs of Mesta rolling mills, auxiliary equipment, and heavy duty machine tools are illustrated in the new MESTA PLANT and PRODUCT BOOK. For your copy, write Mesta Machine Company, Department C, Post Office Box 1466, Pittsburgh 30, Pa.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

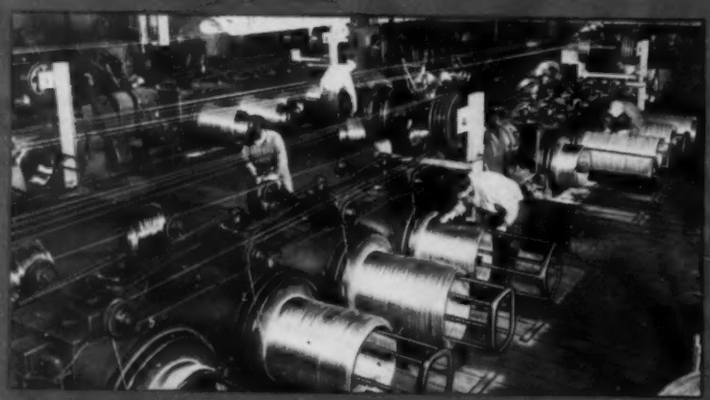


How to STRETCH Production Dollars!



Vaughn

COLD DRAWING MACHINERY



Vaughn Machinery makes metal *and money* go farther in your cold drawing operations. Cost-cutting efficiency in performance, economy of maintenance, and built-in durability are the basic reasons why. *May we discuss your requirements?*

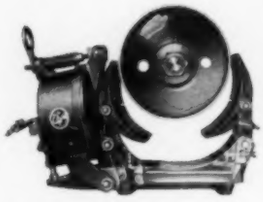
THE VAUGHN MACHINERY CO.

CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT — Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

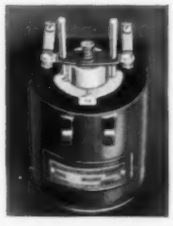
"Quick on the Draw"
VAUGHN MACHINERY
Preferably Used by Leading Wire Mills 1871

Complete Control for Cranes



LONG-LIFE Brakes give high speed performance—with less up-keep.

SHORT-THROW narrow width Cam Master switches are easy on the operator.

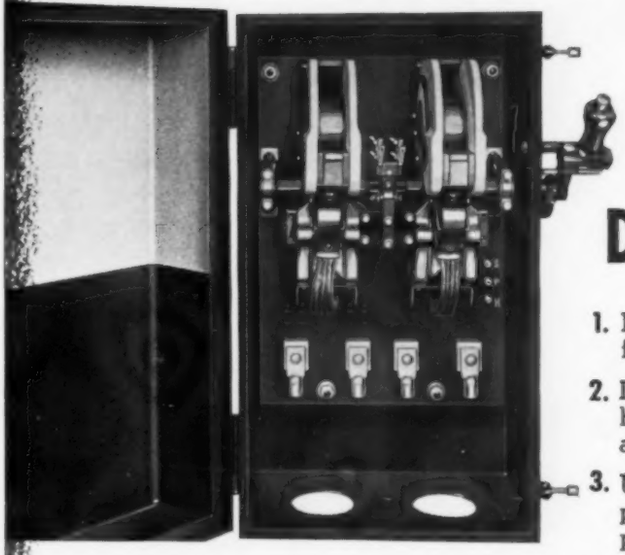


TIME-CURRENT Relay matches acceleration to the d-c load.

YOUNGSTOWN Safety Limit Stop — a positive check against human error.

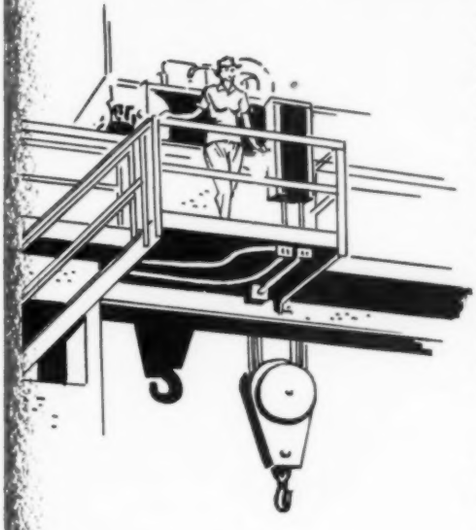
Advantages Gained by Specifying EC&M Bulletin 1024

Safety Disconnect Switch for D-c Cranes



1. Manual - magnetic type for ease of operation.
2. LINE-ARC Design for high arc-rupturing ability.
3. Uses crane control parts — hence, spare-part problem reduced.

Power, Signal-lights, etc., controlled from this one source



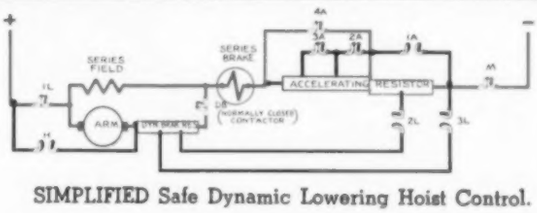
Crane specifications, in general, call for a disconnect switch, mounted on the foot-walk where the operator enters or leaves the crane. A second disconnect switch, installed in the cab within reach of the operator, permits disconnecting the crane in an emergency.

EC&M Manual-magnetic Crane Safety Disconnect Switches combine these two features into a single unit mounted on the foot-walk with an Emergency STOP button giving remote control from the cab. This same disconnect can also be arranged to operate the crane signal-lights to show when power is on or off.

Provision for 3 padlocks, jar-proof operating-handle, complete enclosure and positive lock-out against accidental operation are standard features. Write for Bulletin 1024.

Mounted on foot-walk—
remotely controlled from CAB by Emergency STOP Button—
saves cost of second disconnect switch

TAB-WELD Resistors—no burning where burning would cause high up-keep.



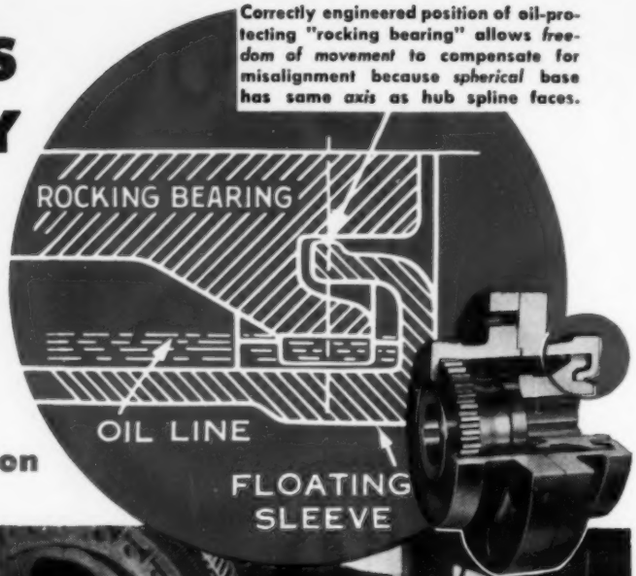
SIMPLIFIED Safe Dynamic Lowering Hoist Control.

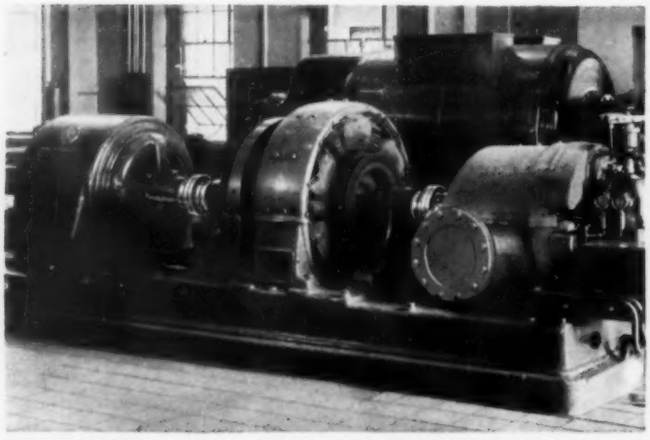
THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO

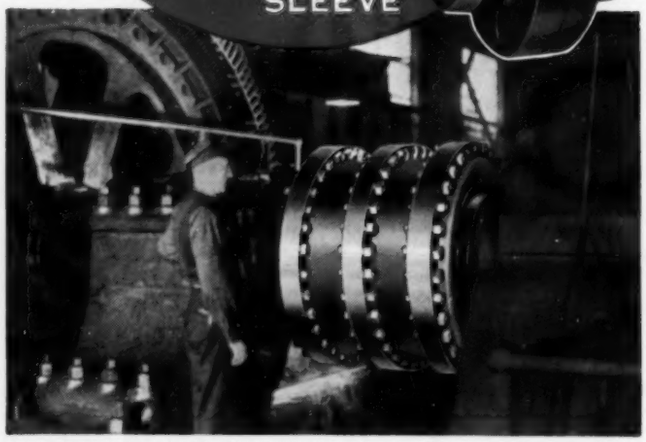
FAST'S COUPLINGS STOP UNNECESSARY SHUTDOWNS IN *Your* PLANT

Exclusive Metal-to-Metal Seal And No Perishable Parts Give Uninterrupted Power Transmission


Correctly engineered position of oil-protecting "rocking bearing" allows *freedom of movement* to compensate for misalignment because *spherical* base has same *axis* as hub spline faces.
ROCKING BEARING
OIL LINE
FLOATING SLEEVE



POWER PLANTS use Fast's Couplings because metal-to-metal seal, absence of perishable parts, virtually eliminate shutdowns!



STEEL MILLS specify Fast's Couplings for equipment of every shaft size to avoid production shutdowns caused by *failure* of ordinary couplings! This Coupling has been in use since 1923!

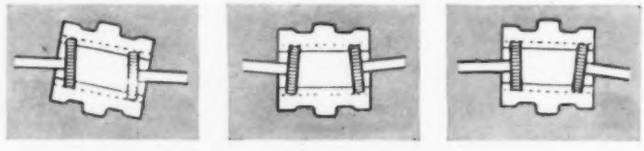
FAST'S Couplings virtually eliminate plant shutdowns because Fast's exclusive metal-to-metal seal gives positive protection, provides uninterrupted power transmission! Complete flexibility to compensate for shaft misalignment is done mechanically. Load-carrying oil is *completely* guarded by exclusive "rocking bearing" that keeps out dirt, grit and moisture without perishable packing rings! Nothing to wear! Nothing to replace! Result: Uninterrupted power transmission for all your installations!

Fast's complete line of Couplings is available right from stock from distribution points coast-to-coast. All Fast's Couplings are backed by years of top engineering experience, Koppers' high standard of workmanship, and unexcelled coupling service including available parts if required by change of drive, *even if your Fast's have been running for 30 years!* Fast's installed on your equipment mean longer machine and motor life, lower upkeep costs, minimum shutdown losses. Write today or use the handy coupon and get all the facts in the new Fast's Catalog. Address: KOPPERS CO., INC., FAST'S COUPLING DEPT., 311 Scott Street, Baltimore 3, Maryland.

Compensate for all Misalignment

The floating sleeve takes a neutral position. All forms of misalignment are compensated for between the lubricated faces of the splines, equally divided between driving and driven members. The entire assembly revolves as one unit.

The exaggerated diagrams below demonstrate this Fast's principle



FAST'S *Self-Aligning* COUPLINGS

KOPPERS

MAIL FREE CATALOG COUPON TODAY!

KOPPERS CO., INC., Fast's Coupling Dept., 311 Scott Street, Baltimore 3, Md.

Please send me your Fast's Coupling catalog No. 47 which contains all the facts and specifications.

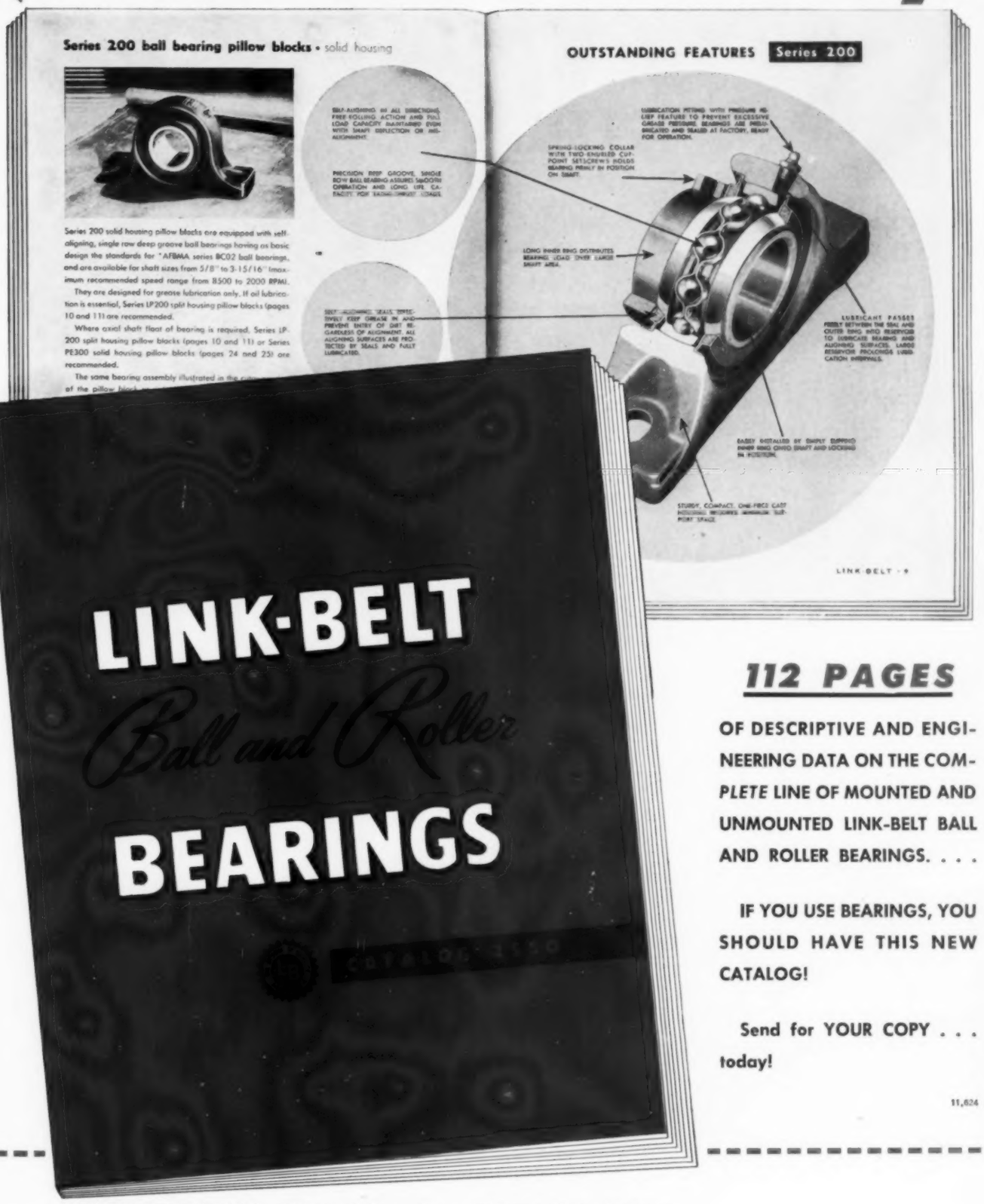
Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

YOUR COPY is Ready!



112 PAGES

OF DESCRIPTIVE AND ENGINEERING DATA ON THE COMPLETE LINE OF MOUNTED AND UNMOUNTED LINK-BELT BALL AND ROLLER BEARINGS. . . .

IF YOU USE BEARINGS, YOU SHOULD HAVE THIS NEW CATALOG!

Send for YOUR COPY . . . today!

11,624

LINK-BELT COMPANY, 519 N. Holmes Ave., Indianapolis 6, Indiana
(or your nearest Link-Belt office or Link-Belt bearing distributor): Please send Catalog 2550.

NAME _____

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Protect Arc Furnace Output

BY ELIMINATING COSTLY HEAT INTERRUPTIONS WITH

Allis-Chalmers ABF-3 Air Blast Arc Furnace Switch

600 and 800 Amperes — Up to 23 kv Service

HERE'S THE POSITIVE ANSWER to repetitive, heavy duty arc furnace switching. Allis-Chalmers ABF-3 Arc Furnace Switch is capable of *thousands of operations* with little or no maintenance . . . as proved by both test and years of operating records!

Designed Specifically for Arc Furnace Duty

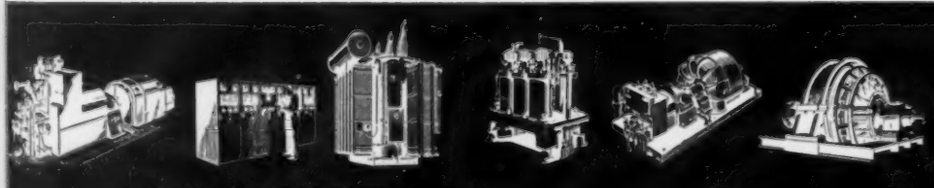
Special design keeps costly shutdown for inspection and maintenance to an absolute minimum. Negligible contact maintenance is one example. It is achieved through the air blast principle of arc interruption which reduces arcing time to *one cycle or less.* Also important is fast circuit interruption, consistently within 4 or 5 cycles.

Porcelain insulators rated 34.5 kv, low inertia parts, and special contact snubber units further contribute to dependable performance of this switch.

Allis-Chalmers ABF-3 air blast switch is a complete operating unit, ready to install and operate. All electrical controls, and air generating and storage equipment are included in the dust-proof metal cubicle.

Your nearby Allis-Chalmers circuit breaker specialist will be glad to discuss these and other advantages of the ABF-3 air blast arc furnace switch with you. Call him today, or write direct. A-2865

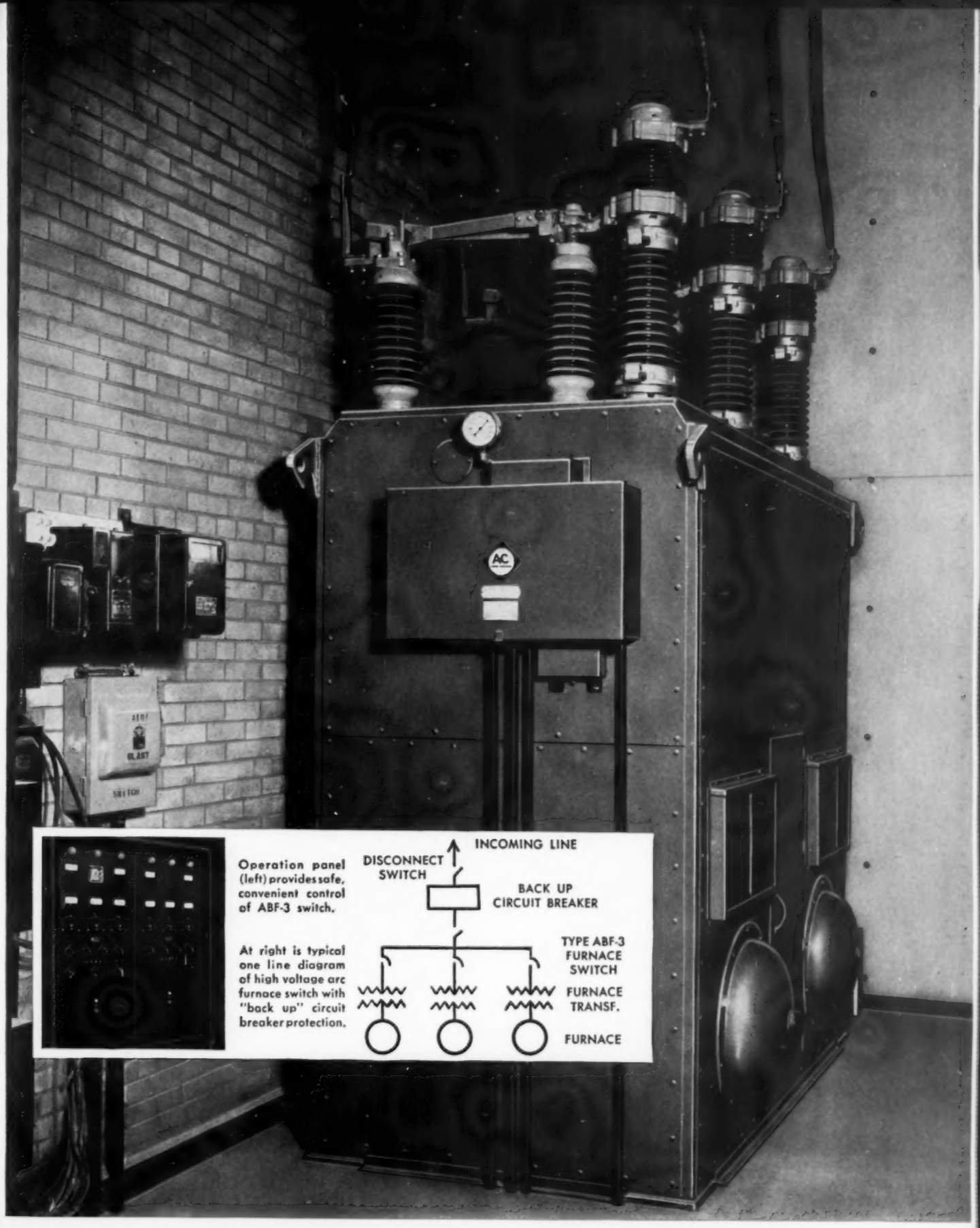
ALLIS-CHALMERS, 1020A SO. 70 ST.
MILWAUKEE, WIS.



POWER & ELECTRICAL — Steam Turbines, Condensers, Water Conditioning, Power Transformers, Switchgear, Unit Substations, Circuit Breakers . . .

UTILIZATION & PROCESS — Motors, Blowers, Rectifiers, M-G Sets, Betatron, Pumps, Compressors, Regulex Exciters, Texrope V-Belt Drives . . .

ALLIS-



Operation panel (left) provides safe, convenient control of ABF-3 switch.

At right is typical one line diagram of high voltage arc furnace switch with "back up" circuit breaker protection.

S-CHALMERS

A-C ALLIS-CHALMERS

POWER, ELECTRICAL AND PROCESSING EQUIPMENT FOR IRON AND STEEL

new drive for 66" continuous pickling line permits faster acceleration, cuts maintenance costs!

General Electric-engineered drive simplifies operation, reduces downtime, helps increase strip steel output!

Of outstanding interest to steel mill operators is a new 66-inch high-speed continuous pickling line now in operation in a large Eastern mill. Electrically engineered, co-ordinated, and equipped by General Electric, it provides important features such as these to increase output and cut costs:

Acceleration rates up! Amplidyne control of separate adjustable-voltage generators for the entry and delivery ends makes possible much faster acceleration and deceleration, limited only by the commutating ability of the motors and generators.

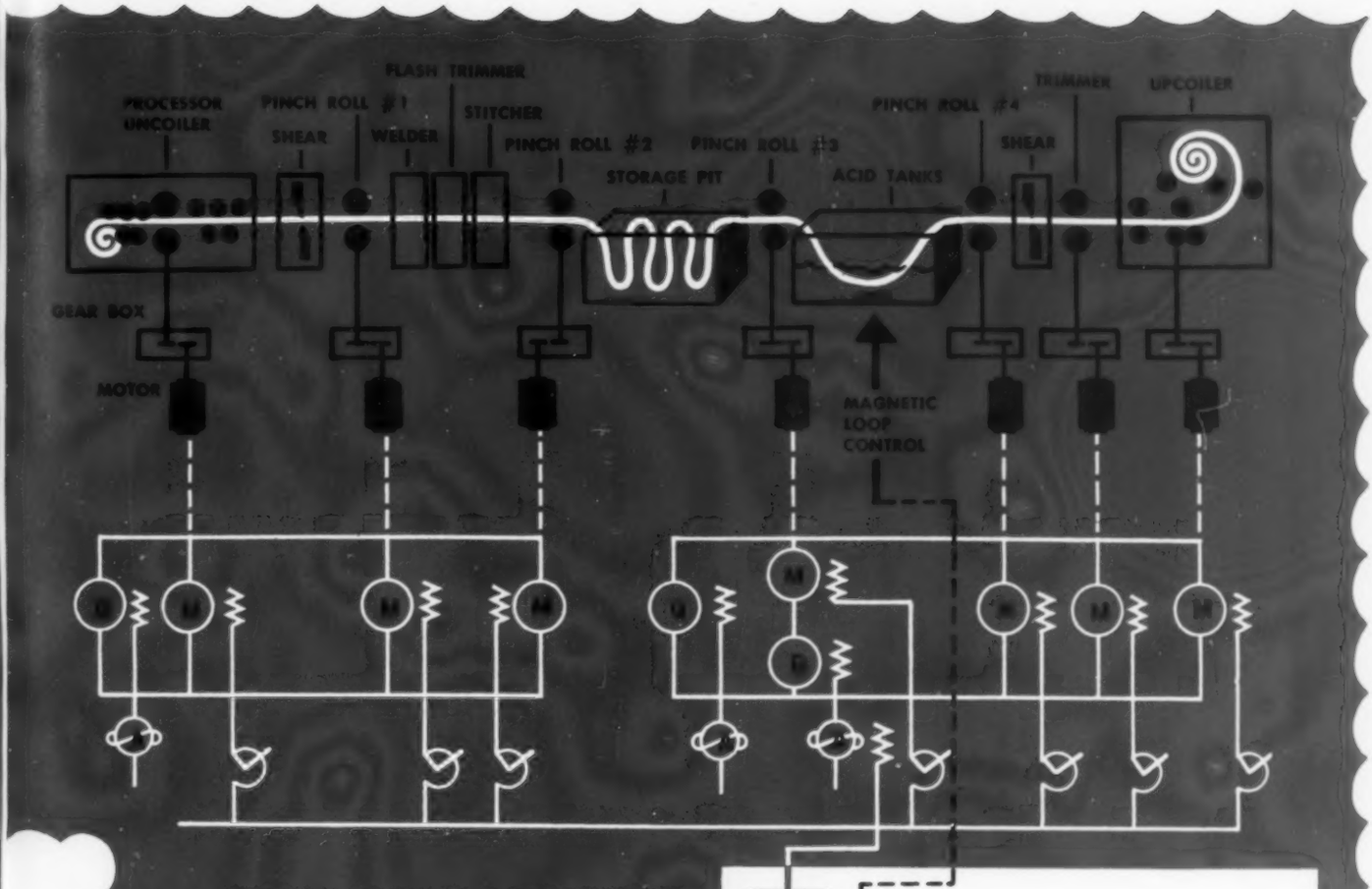
Maintenance costs down! A new magnetic loop control utilizing for the first time the Amplistat—General Electric's new static magnetic amplifier—regulates the loop position in the pickling tank. By regulating the loop position without the use of dancer rolls or dancer roll rheostats, the problem of corrosion of these rolls and rheostats—and resulting costly downtime—is eliminated.

Output increased! Faster acceleration and deceleration of the drive makes it easier for operators at the entry end to keep up with the delivery end, simplifies operation, and helps maintain a higher rate of output.

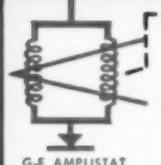
Here is further proof that—whatever *your* drive problem—experienced G-E engineering can help turn it into a successful installation. A G-E steel mill specialist will be glad to discuss it with your technical staff. Phone him at your nearest G-E office. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

660-61



HERE'S HOW IT'S ENGINEERED!



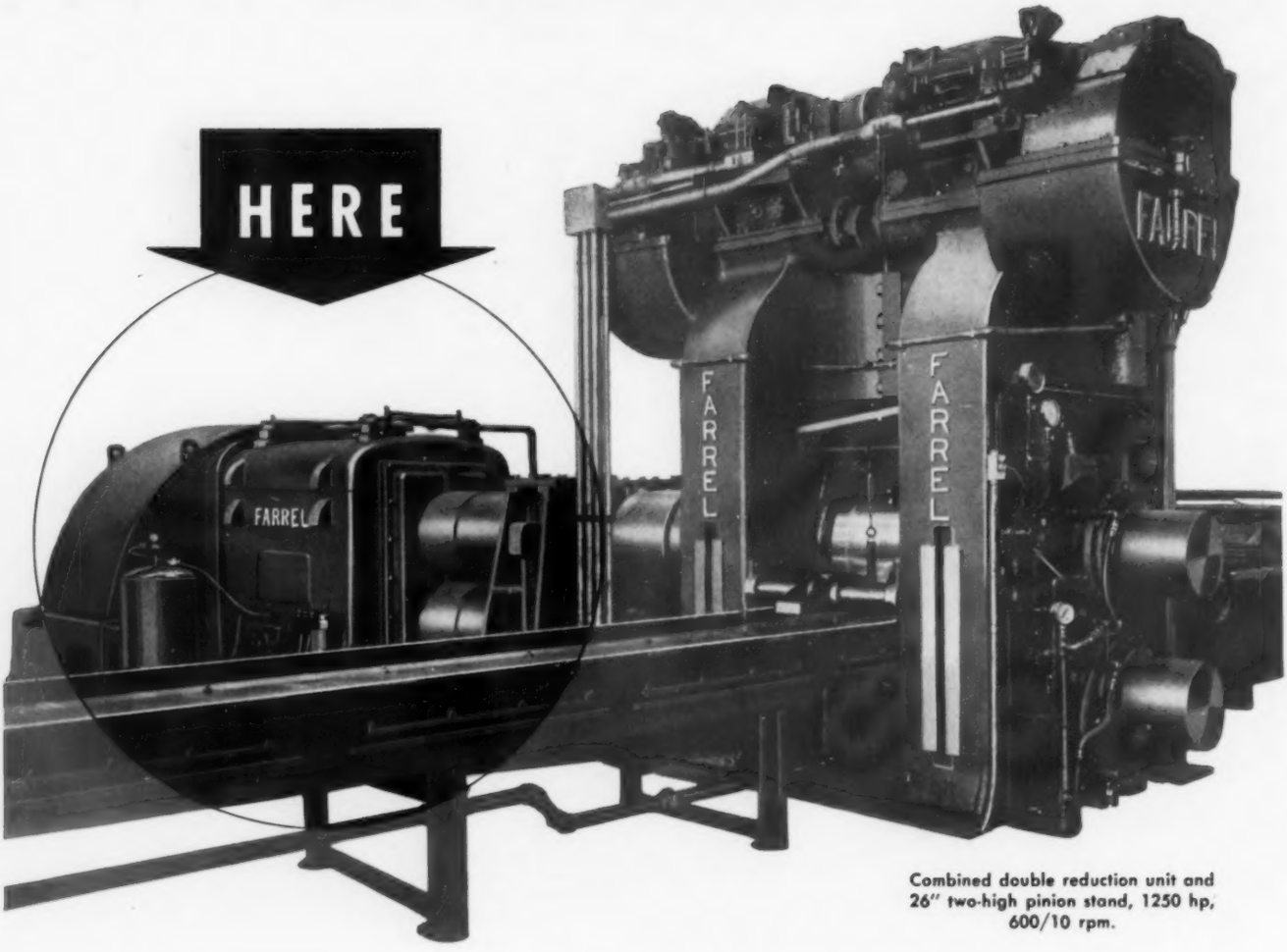
The drive motors (M) for the various machines which make up this continuous pickling line are divided into an entry section and a delivery section. Each section is supplied by an individual generator, making it possible to operate them independently. Each generator (G) is excited by an amplidyne exciter (A), which regulates voltage and provides current limit for rapid acceleration and deceleration. Speed adjustment of individual machines in each section is accomplished by motor field control. A magnetic loop control regulator automatically maintains the position of the strip catenary in the acid tanks. The signal produced by the pick-up unit is amplified first by an Amplistat and then by an amplidyne exciter. The amplidyne excites a booster generator (B) in series with No. 3 pinch roll motor, and thus controls the speed of No. 3 pinch roll to correctly position the strip.

Shown here are the flash welder and entry-end control desk. The tail end of each coil is welded to the front end of succeeding coils in order to provide an endless strip through the pickling tanks. Delivery strip speed is 500 FPM, making this G-E equipped line one of the industry's fastest.

another example of

GENERAL ELECTRIC

drive engineering at work!



Combined double reduction unit and 26" two-high pinion stand, 1250 hp, 600/10 rpm.

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Universal Mill Spindles
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Gear Drives of Any Capacity
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The combination gear drive and pinion stand that delivers power from the motor to your mill should give trouble-free power teamwork, year after year. To do this it must be fitted to the job. That's where Farrel engineers come in—to give you a unit designed for your mill.

All you have to do is to provide us with the drive requirements: Power and speed . . . type and gauge of metal to be rolled . . . process (hot or cold) . . . nature of load (continuous or intermittent) . . . type of drive motor . . . etc. We will then supply you with a unit that has been *engineered for the job* it will have to do.

Call us when you want a drive designed and built for continuous, trouble-free operation. Our engineers will be glad to discuss gear drive problems with you at any time, without obligation. Why not call on them?

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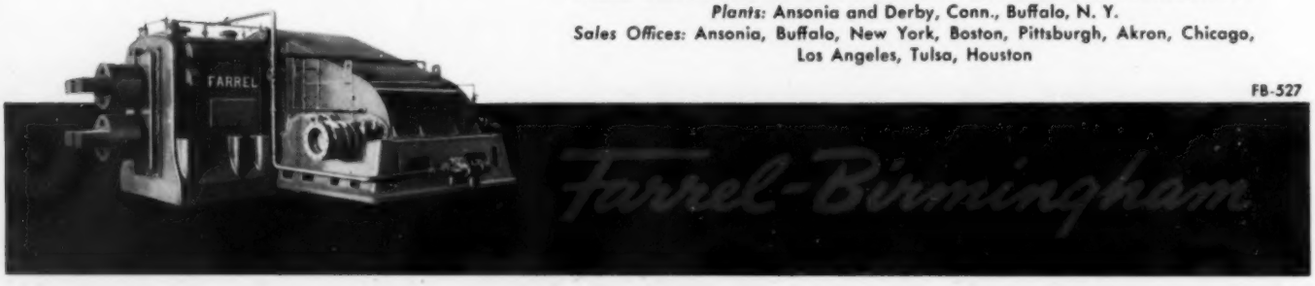

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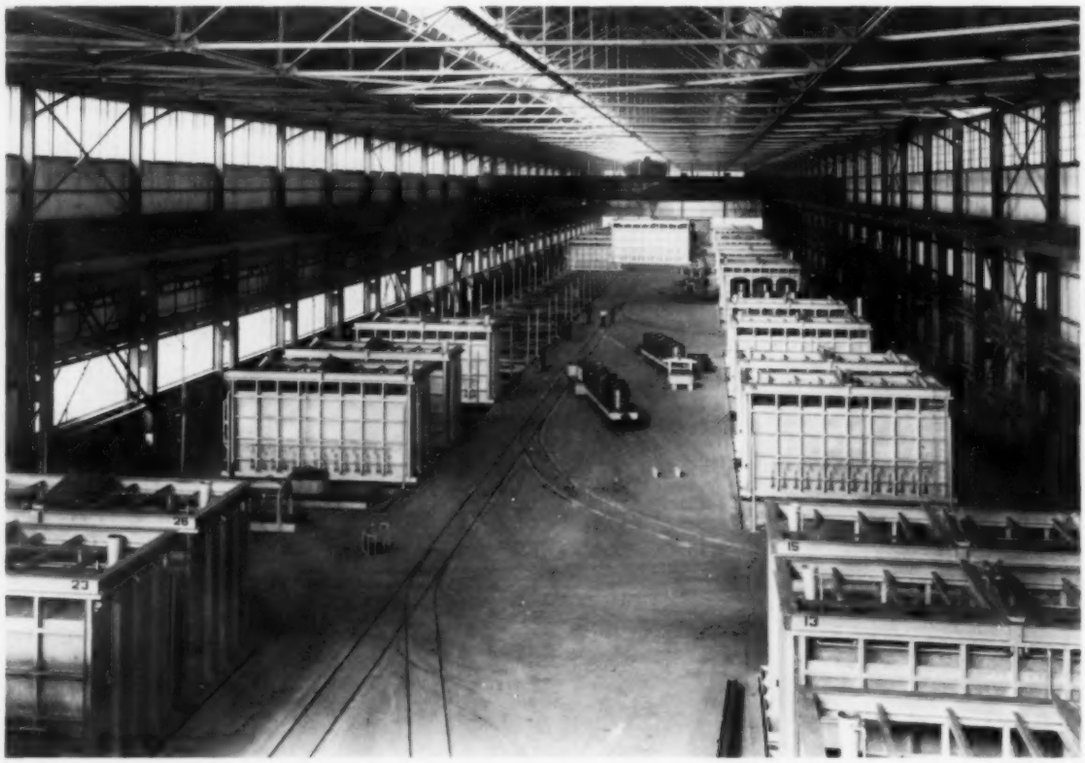

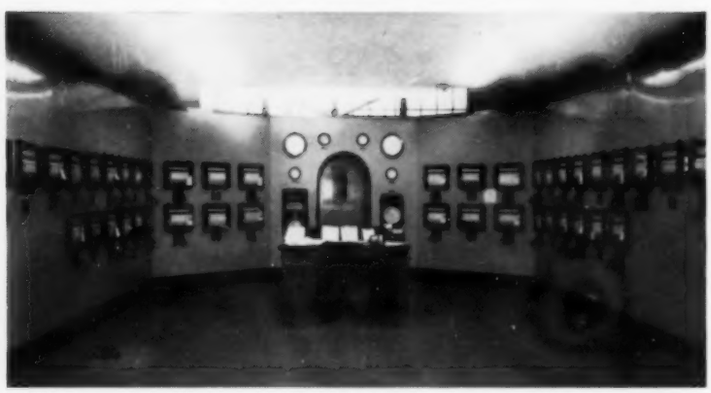

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Shall I continue outmoded, manual conditioning of billets at excessive costs . . . or

Shall I invest in equipment that will cut my billet-conditioning costs?

Many leading steel producers have already made the "profit-wise decision" to install Bonnot Billeteers to take expensive, mankilling hand labor out of the billet-conditioning. And in each instance, Billeteer users describe their benefits like this:

- ★ ***Cut costs as much as 56% over hand conditioning methods. No wasted billet production, because flaws of any depth are quickly cut out.***
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- ★ ***Fewer accidents; quoting one user, "only one disabling accident in 490,000 Billeteer-hours of operation."***
- ★ ***Steady production on schedule, shift after shift, YEAR AFTER YEAR.***

Get the whole story of how a Bonnot Billeteer can bring consistently, profitable efficiency to your billet-shed. Write today.

Engineered for Improved Production

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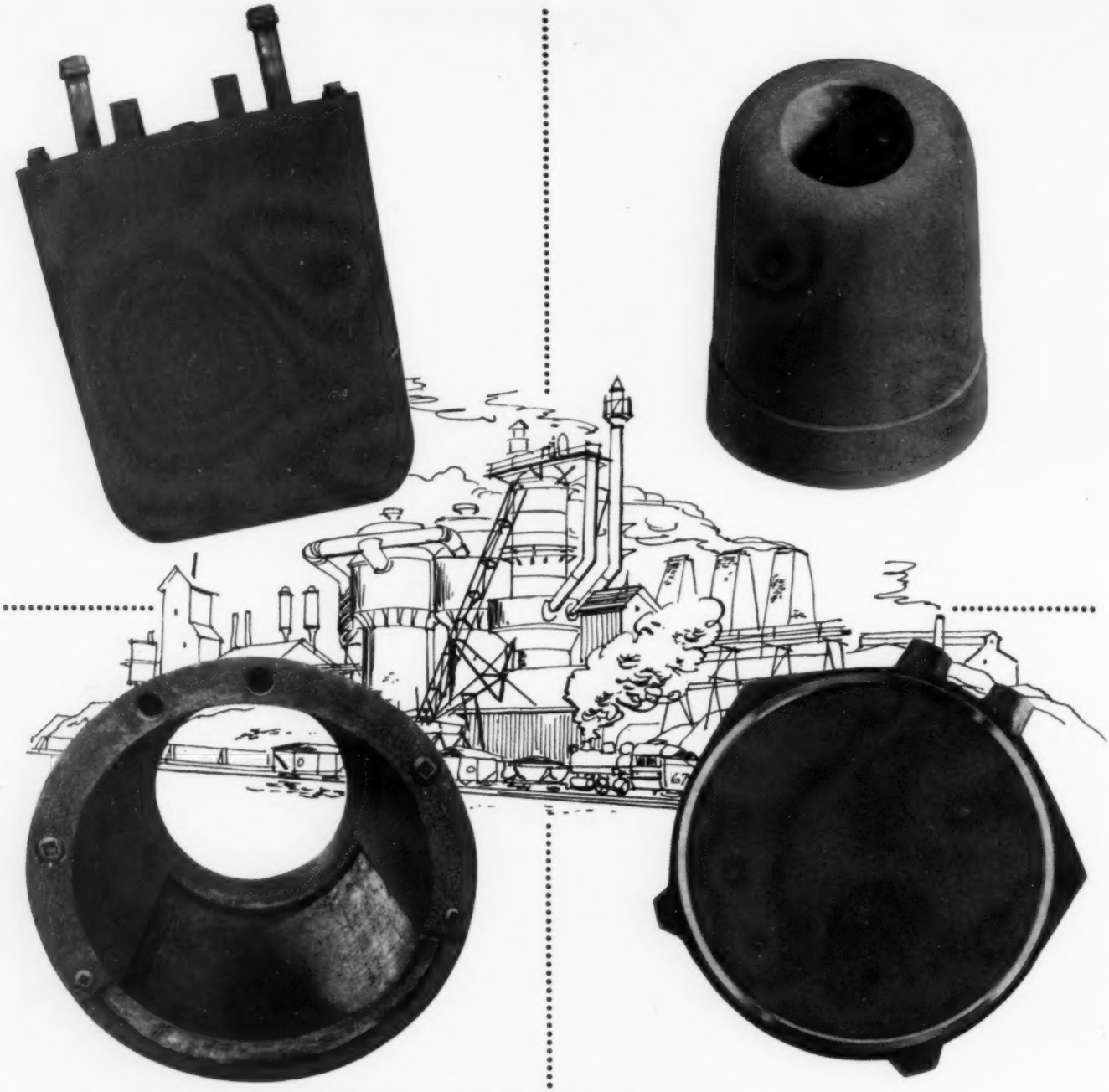

N-B-M COPPER CASTINGS . . . the right answer for greater production between stack shutdowns

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N-B-M Copper Castings are the result of improved alloying and close foundry control perfected in our metallurgical and engineering research laboratories. These castings provide greater heat resistance for your most troublesome burn-out points, greater production between stack shutdowns. Always specify N-B-M Copper Castings—they give you longer, more economical service.

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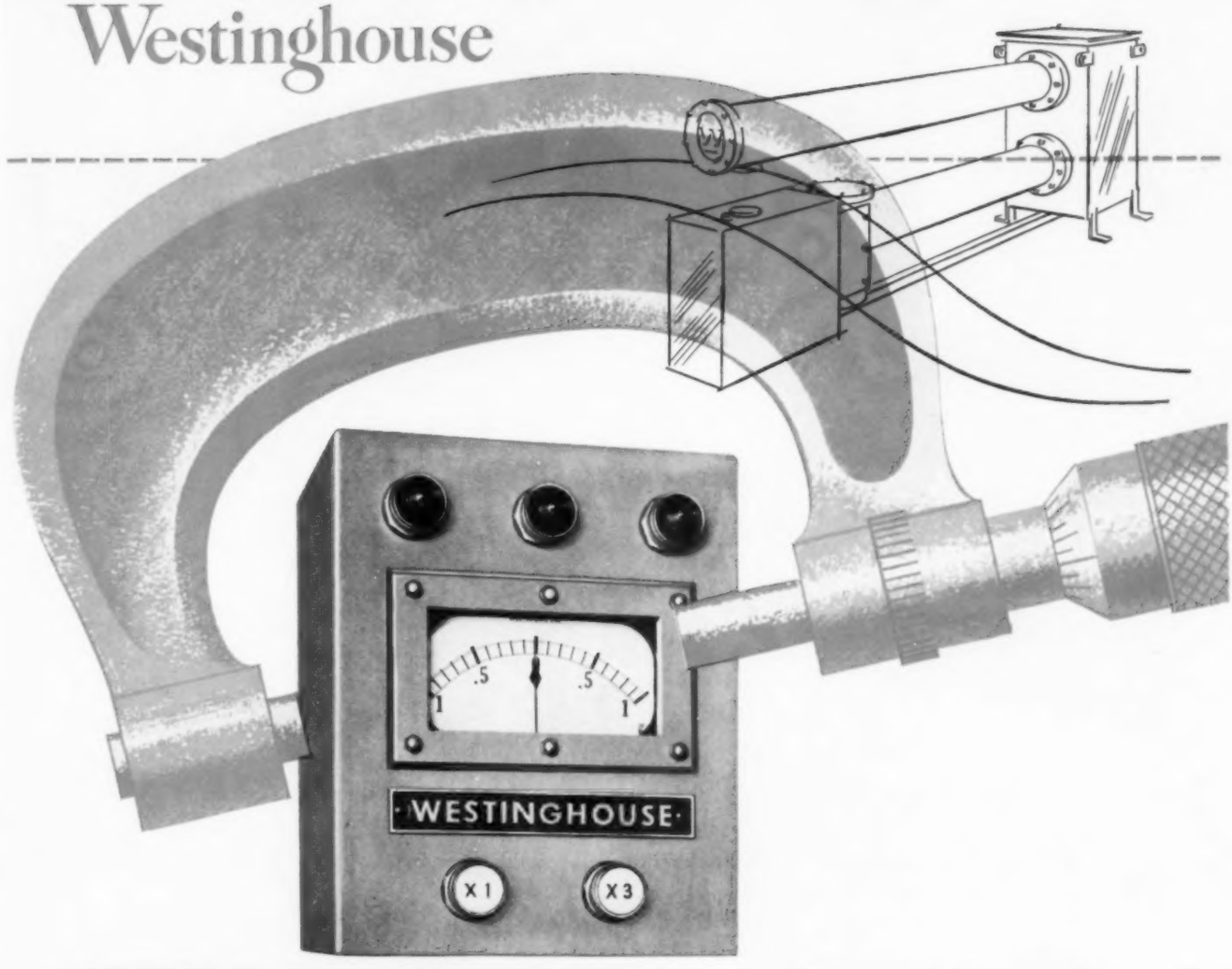

STOP COSTLY "overs" and "unders"

. . . with this X-RAY Thickness Gauge

Facts speak for themselves where quality and economy are dependent upon *rigorously* keeping to thickness standards. Compare the Westinghouse X-Ray Thickness Gauge with your present method of gauging the steel strip on high-speed, cold reduction mills or slower classification lines. It's FASTER . . . employs the direct comparison method of gauging which is independent of strip speed, yet holds to minute tolerances. It's FOOLPROOF . . . no mechanical gauging wheels to maintain . . . no contact between gauge and sheet . . . no damage to strip surface. It's POSITIVE . . . no manual handling of calibration samples . . . operation and calibration of the gauge are handled by remote control from the operator's control panel. And above all, it's ACCURATE . . . tolerances are maintained to within ± 2% . . . variations show up immediately on the indicating meter shown above, or may put reject gates into operation.

Consider these time and moneysaving "extras", too:

- Rugged mechanical construction and complete circuit stability which prevent costly shutdowns.
- No loss of time for setups . . . each new run can be set up rapidly and easily.
- Easy installation for lateral strip scanning.

You've been asking for a thickness gauge like this . . . and now it's here! Controlled accuracy that insures quality and assures economy. Your local Westinghouse representative can give you all the facts today. Call him or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-08227

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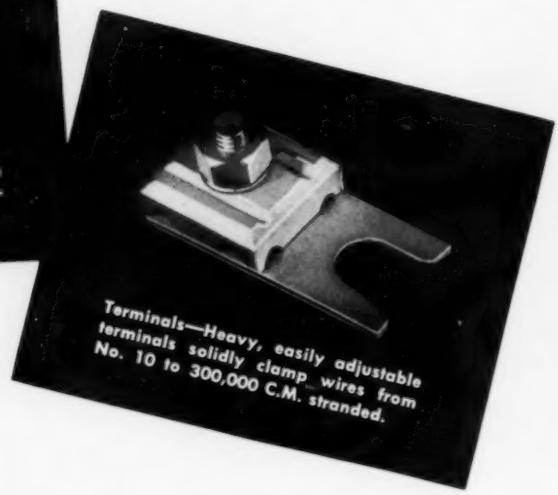
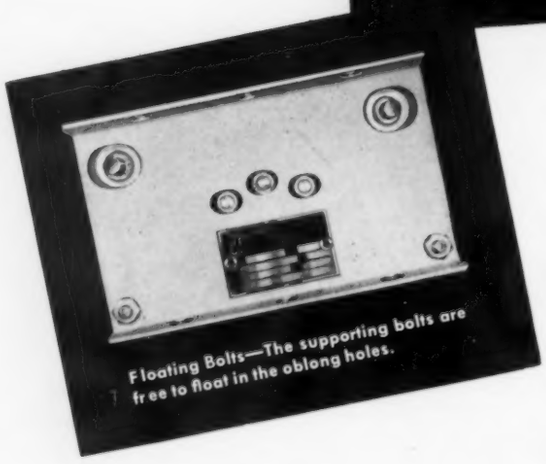
P-G Steel Grid—Designed to eliminate hot spots and insure even heat distribution.



Terminals—Heavy, easily adjustable terminals solidly clamp wires from No. 10 to 300,000 C.M. stranded.



Floating Bolts—The supporting bolts are free to float in the oblong holes.

3 Plus Factors

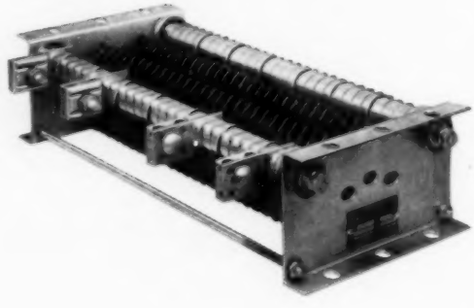
IN P-G Steel Grid Resistors

for BETTER PERFORMANCE with LESS MAINTENANCE!

1. **GRIDS** are punched from corrosion-resisting, special chromium alloy steel sheets and retain their mechanical strength even at a red heat.

2. **FLOATING BOLT** construction, as used in P-G Resistors, allows the grids to expand under heat. This feature prevents warp or buckle since the grids are free to move within their maximum limits of expansion.

3. **TERMINALS** are heavy steel and malleable iron. The open eye in the terminal plate makes it easily possible to move connection to any position in the bank.



These 3 plus factors . . . combined with many other P-G practical features of design, plus steel and mica as basic materials, assure long resistor life.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

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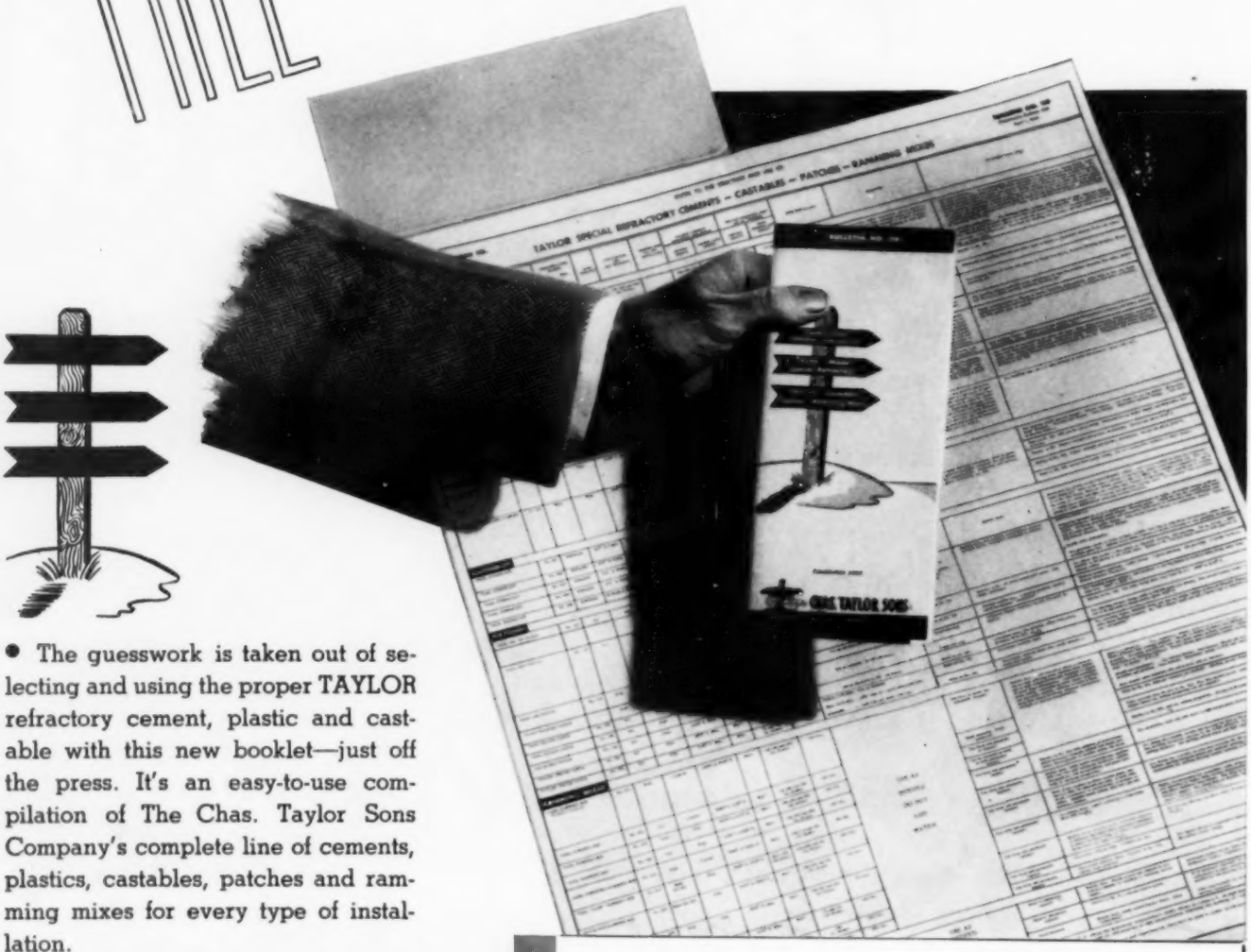

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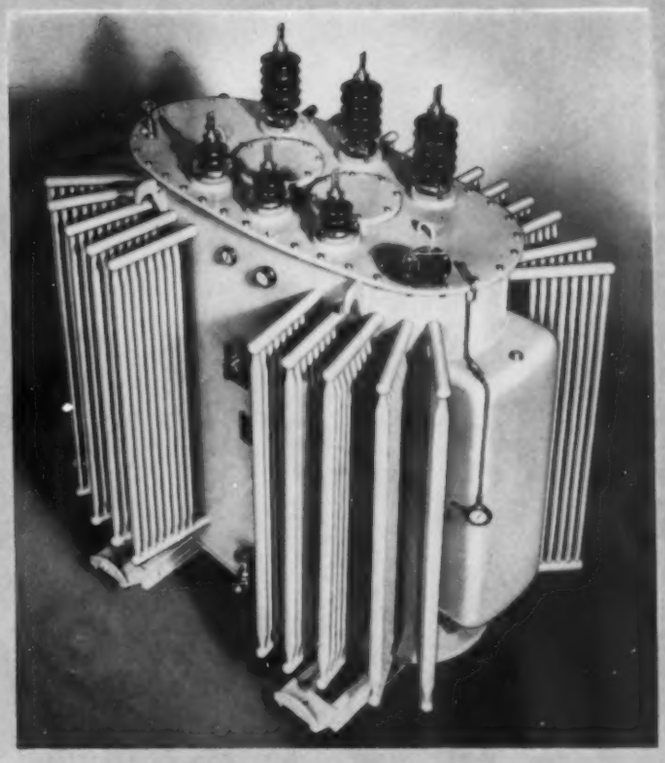

on how you can **SAVE UP TO 8%** by specifying

PENNSYLVANIA STANDARD PARTS POWER TRANSFORMERS

? WHO Can Use Pennsylvania Standard Parts Power Transformers?

Practically all utilities and industrials can use Pennsylvania Standard Parts Power Transformers because the electrical ratings and accessories are in accordance with A.S.A. and NEMA Standards. To meet a wider range of system requirements, variations are permitted both in accessories and in electrical characteristics. For example: Any accepted method of oil preservation can be had with Standard Parts transformers.

? WHAT Are Pennsylvania Standard Parts Power Transformers?

They are single or three phase Power Transformers, now manufactured in sizes up to 10,000 Kva and up to 69 Kv. Transformers are "Standard" when they conform to standard voltage ratings and are equipped with standard accessories in standard locations. For such transformers a full discount of up to 8% is applied. When voltages are other than standard, but within a certain voltage rating, slightly lower discounts are applied.

? WHY Do Standard Parts Power Transformers Sell for Less?

Because quantity production methods of manufacturing, coupled with the use of standard designs and standard parts, shorten engineering and production time which, in turn, reduces the price of the transformer by as much as 8%.

? WHEN Can Deliveries Be Made on Standard Parts Power Transformers?

On some ratings, deliveries can be made 3 or 4 weeks from the time an order is entered. On other larger ratings, deliveries can be made in a comparatively short time.

? WHERE Can More Information on Standard Parts Power Transformers Be Obtained?

By writing to Pennsylvania Transformer Company, Box 330, Canonsburg, Pennsylvania and asking for a copy of Catalog No. 1492.

Pennsylvania

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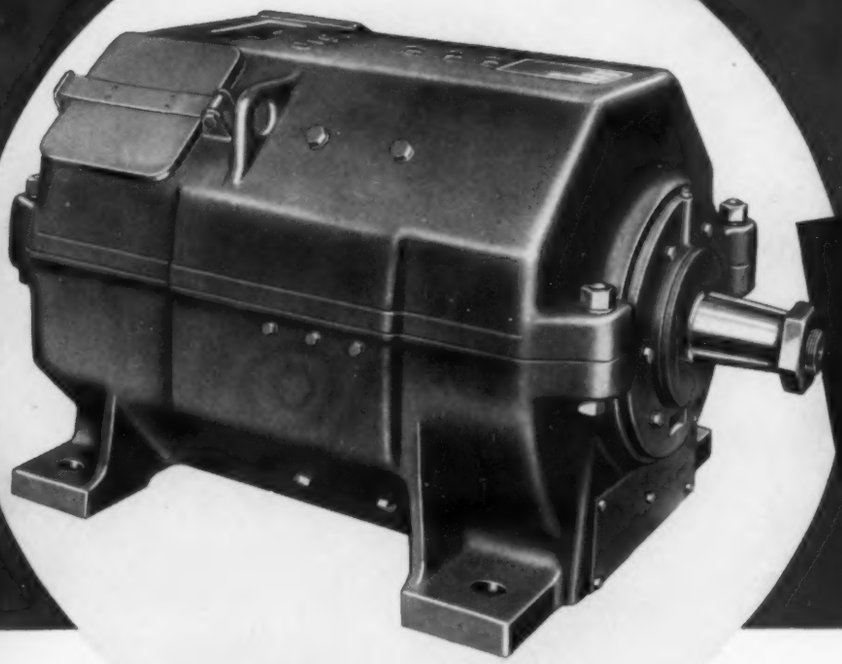
FORM W 600 SERIES

AUXILIARY MILL MOTOR

For Heavy Duty Mill and Crane Service



BUILT TO THE STEEL INDUSTRY'S SPECIFICATIONS!

Here's the mill motor the steel industry wanted. This new improved Form W 600 Series by Crocker-Wheeler is built to A.I.S.E. Standard No. 1. And it's available now!

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Crocker-Wheeler engineers are accredited specialists in building motors for cranes and heavy auxiliaries in steel mills. C-W designed the first mill type motor as far back as 1905, and has been making motor news in the steel industry ever since.

Find out more about the new Crocker-Wheeler Auxiliary Mill Motors—their greater efficiency, ease of maintenance and other unique advantages. Send today for Bulletin. Write Crocker-Wheeler Electric Mfg. Co., Ampere 3, N. J.

✓ CHECK THESE LOW MAINTENANCE — LONG-LIFE FEATURES

FIELD COILS Wound on mold over mica cell. Mica-washers at top and bottom of coil. Glass tape applied over cell, washers, and coil. Coil is filled layer by layer, during winding, with insulating compound that resists high temperatures, moisture, and oil, and provides an extremely homogeneous structure.

ARMATURE COILS Conductors are silicone-bonded, double-glass-covered wire. Slot portion of coil insulated with 4½ layers of glass-backed mica wrapper lapping with layers of glass-backed mica tape which extend around the coil bends and nose for reinforcement. Entire coil taped with closely woven glass tape.

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GET COMPLETE DETAILS of these and many other reasons why the new Crocker-Wheeler Form W 600 series is your best buy in mill motors. Ask for Bulletin SL-620-1.

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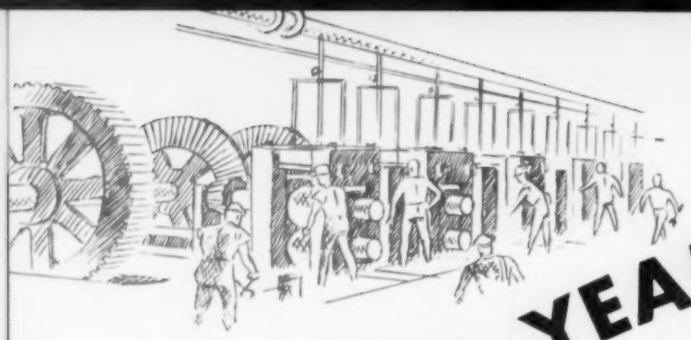
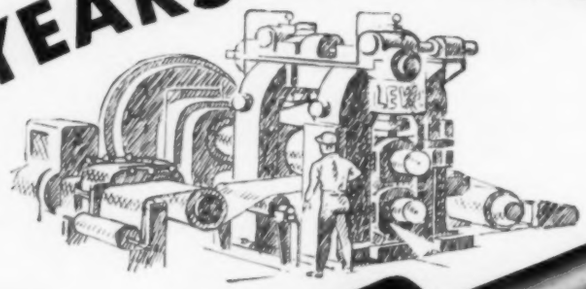


OVER 90 YEARS EXPERIENCE



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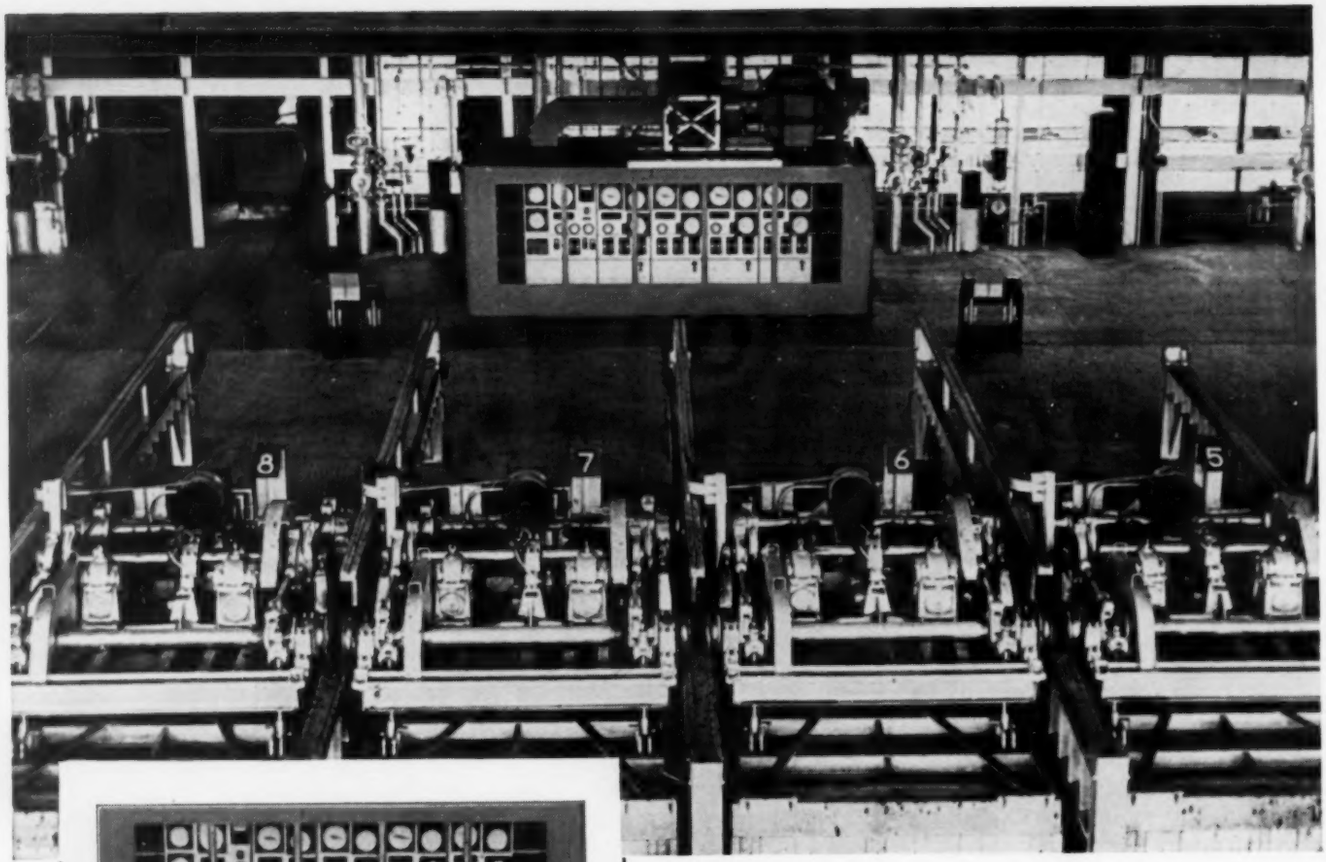

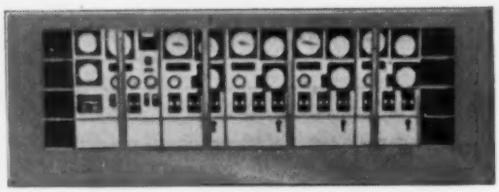

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Precision temperature control is maintained by means of thermocouples and Radiamatic measuring elements.

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ElectroniK Control is accurate, fast and dependable. Its flexibility is ideal for all steel producing operations . . . permits it to keep pace with even the most advanced techniques.

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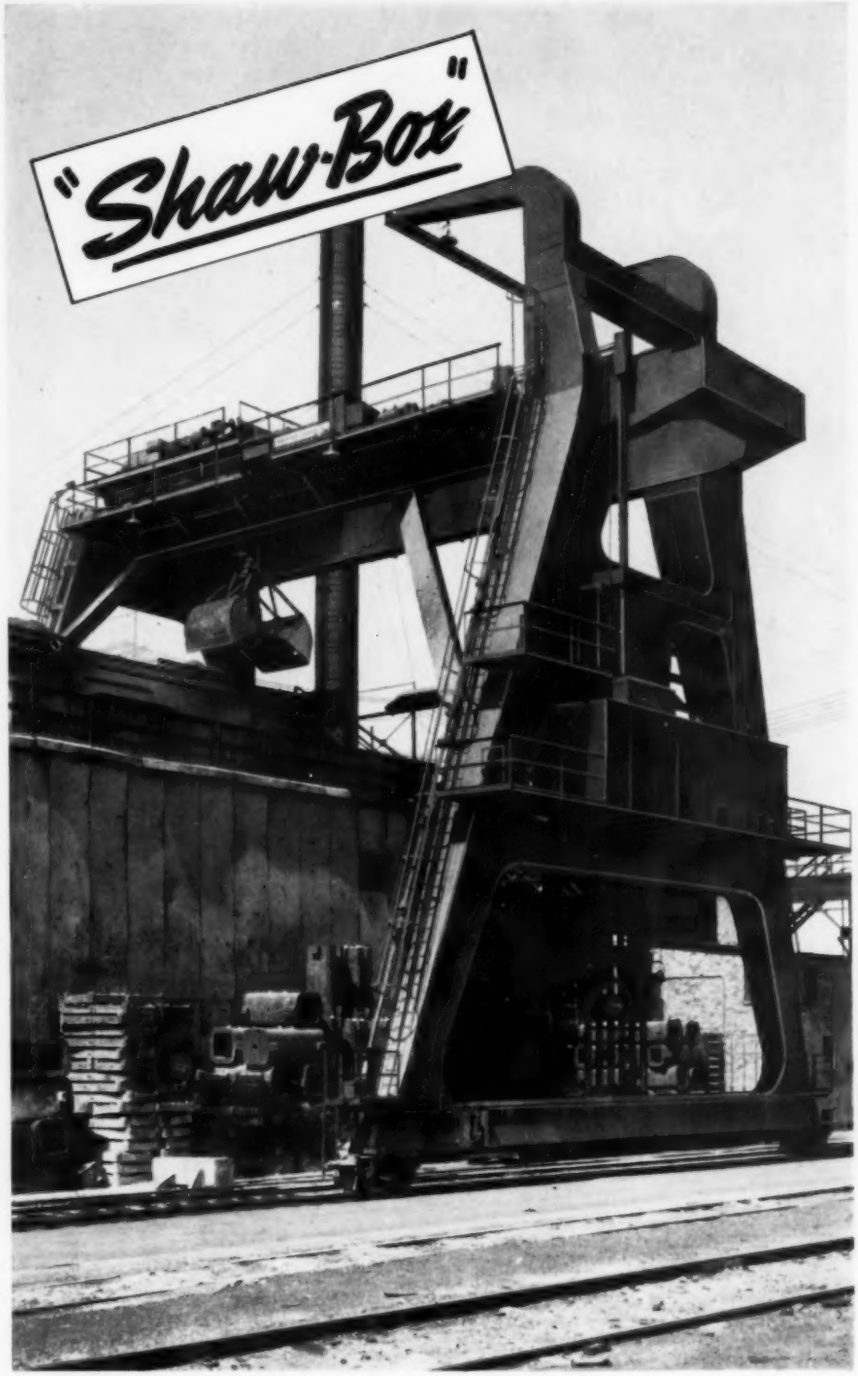

GANTRIES

When your Gantry Cranes are "Shaw-Box," you have cranes containing the advanced engineering and material values that insure reliable, efficient and low cost crane performance.

The design of "Shaw-Box" Gantries provides for the utmost in rigidity, freedom from whipping under the most rigorous conditions, and ease of erection in the minimum of time. The modern design details and manufacturing techniques employed by "Shaw-Box" to produce them results in the kind of cranes that steel men strive for in their A.I.S.E. specifications. The "Shaw-Box" construction of girder, leg, truck and drive mechanisms insures the continued lower operating and maintenance costs for which "Shaw-Box" Gantries are famous.

Be sure to send all your inquiries and specifications for Steel Mill Cranes and Gantries to "Shaw-Box."

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

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SHAW-BOX CRANE & HOIST DIVISION

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Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties. Makers of 'Asheroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.

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- REDUCE FUEL CONSUMPTION
- STOP BURNING STEEL
- STOP WASHING INGOTS
- INCREASE REFRACTORY LIFE
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- ELIMINATE RECUPERATORS & GENERATORS
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Fort Pitt Bridge Works Subsidiary
PITTSBURGH, PA.

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PUNCHING
SHEARING
BLANKING
up to
1200-TON
capacity?
Buffalo
MILL TYPE
SHEARS
BULLETIN No. 3650
BUFFALO FORGE COMPANY
BUFFALO 5, N. Y., U. S. A.
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this BULLETIN
● Get facts on these big-capacity machines that give 250 to 1200-ton cuts!
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● Ready for PUNISHMENT! Heavy electrically-welded steel plate frame provides absolute rigidity and endurance.
● Write for Bulletin 3650 for the shear that will cut YOUR punching, shearing and blanking costs!
"Buffalo" No. 51 High Stroke Mill Type Shear for bar stock with automatic air-operated Tilting Stripper. One of twelve shears to choose from to fit your operation.
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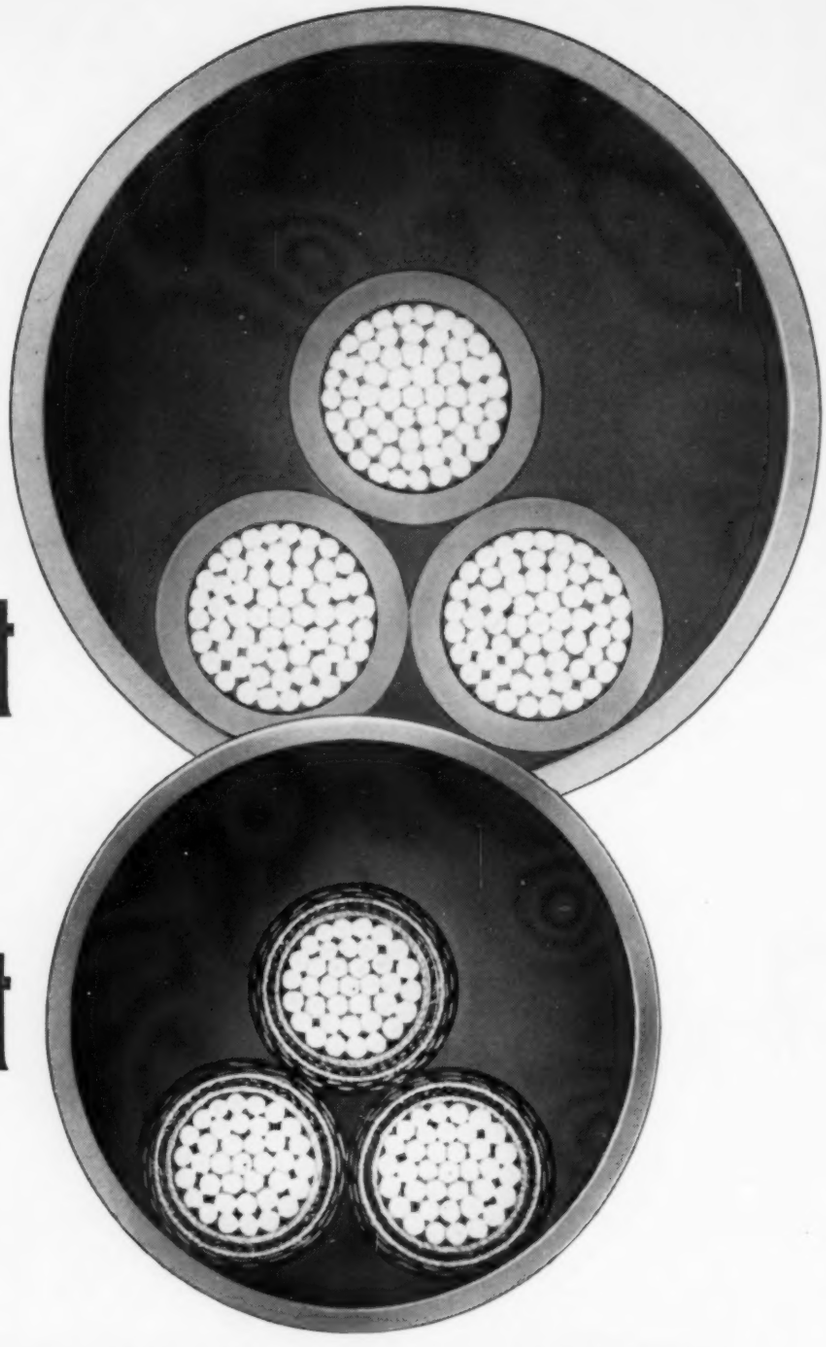

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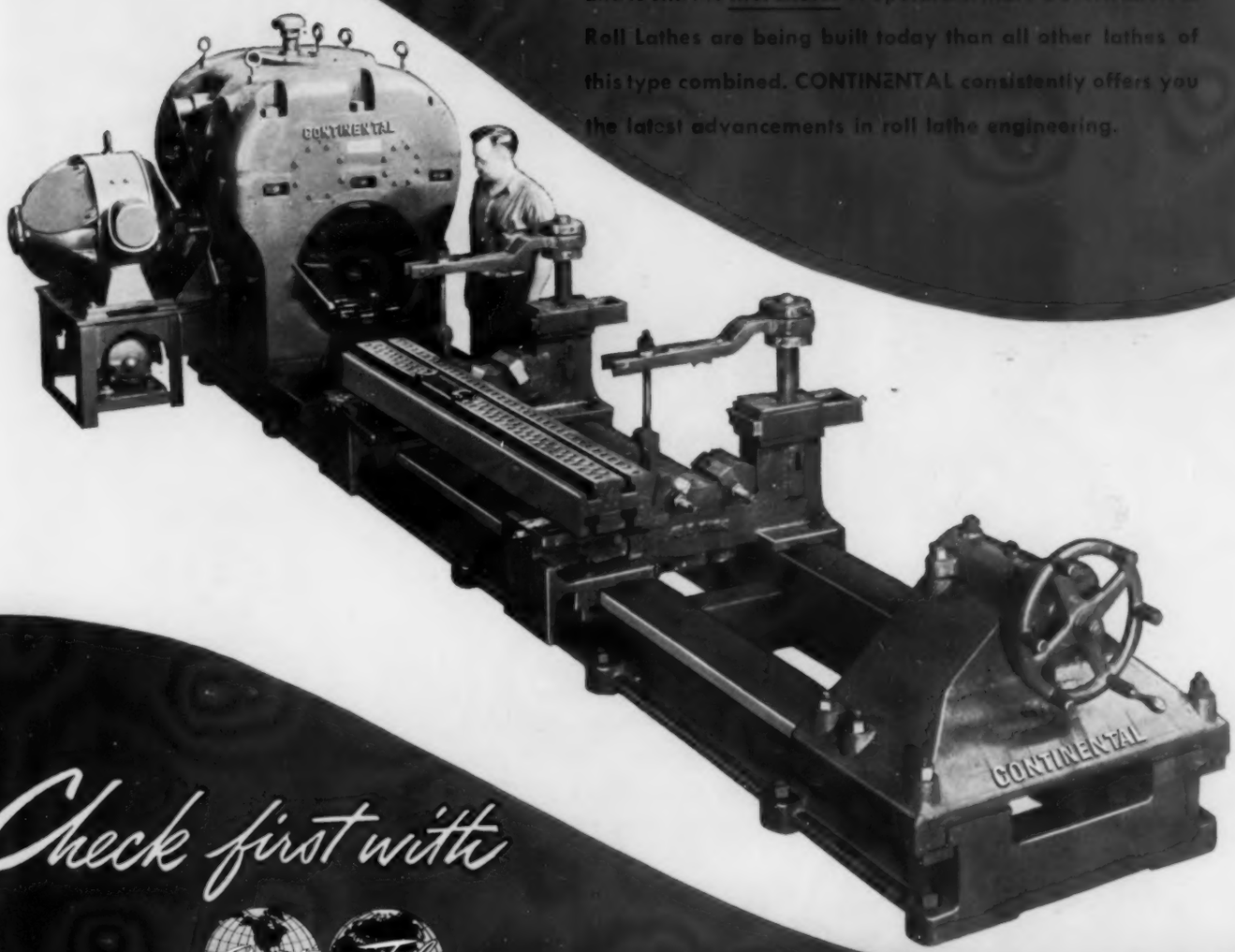

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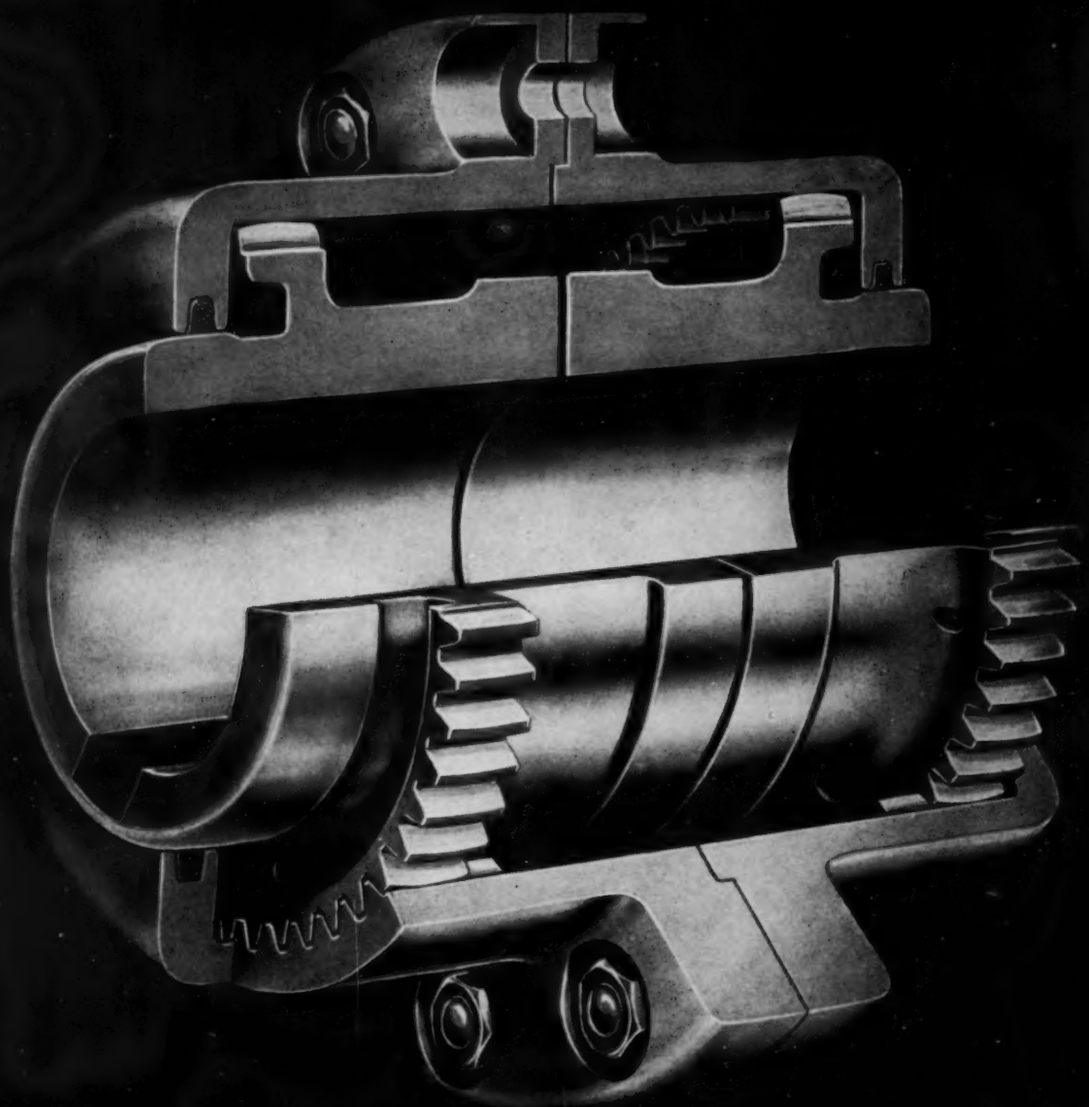


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

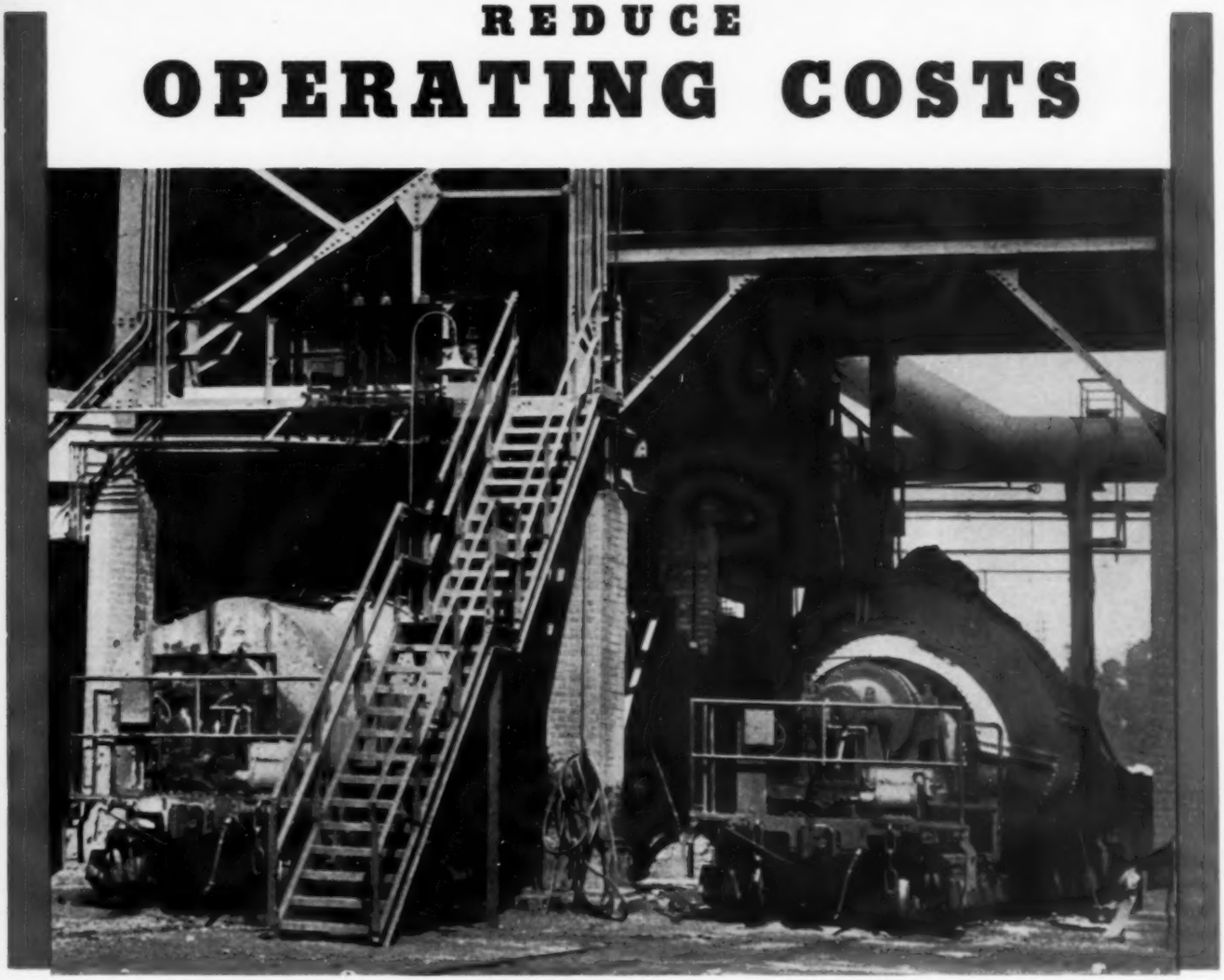
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

TREADWELL

MIXER TYPE HOT METAL CARS
REDUCE
OPERATING COSTS



BUILT IN CAPACITIES TO MEET YOUR REQUIREMENTS

75 to 210 Net Tons

279 OF THESE CARS NOW SERVE THE STEEL INDUSTRY

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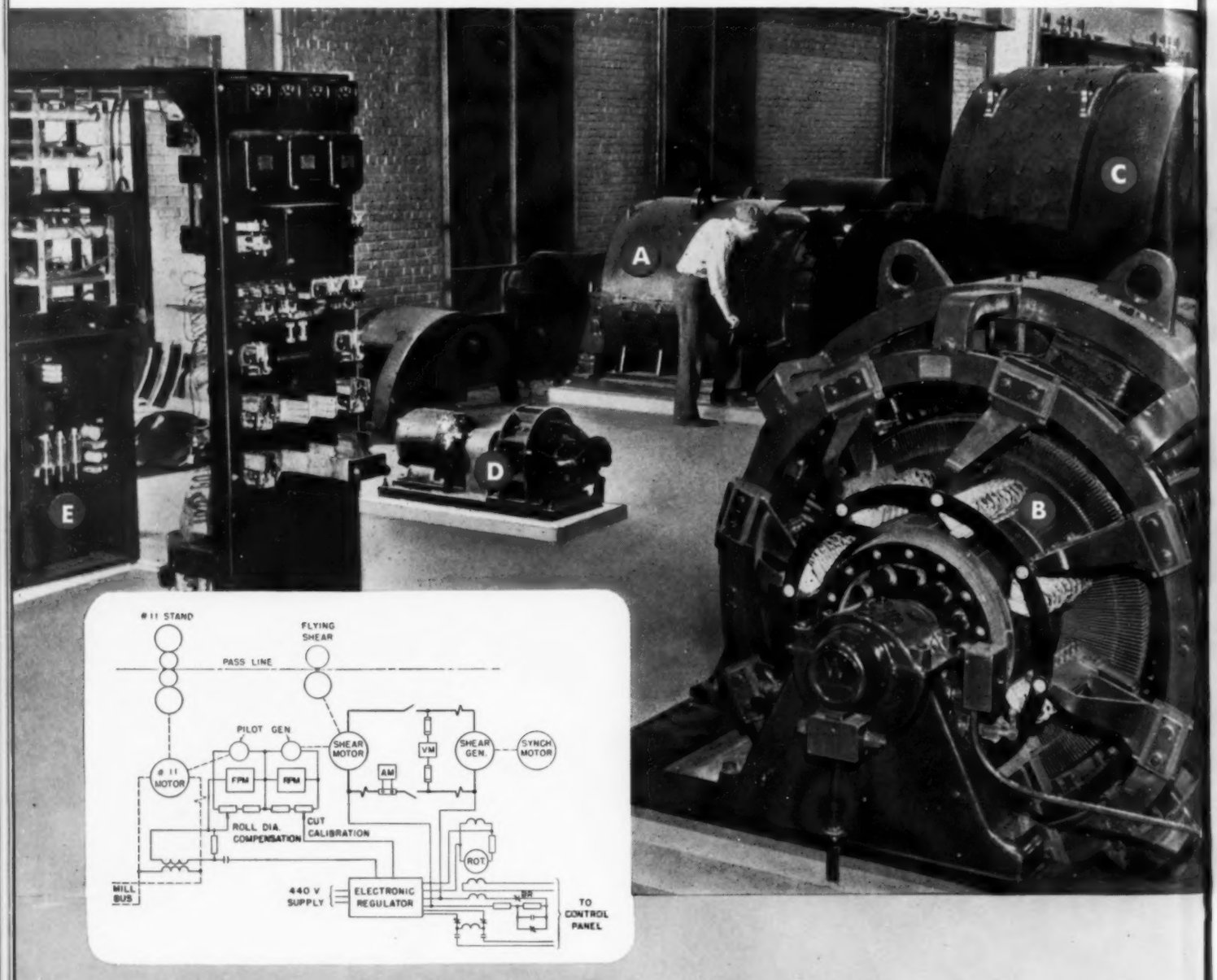
YOU CAN BE **SURE**.. IF IT'S

Westinghouse



IMPROVED FLYING SHEAR DRIVE

This Flying Shear Drive is a good example of the way Westinghouse coordination pays off. Designed for hot strip mills, it cuts strip into *accurate* lengths, eliminates the operating and maintenance difficulties inherent in mechanical and hydraulic drives. Here's how it works.

The Drive equipment is in the mill motor room. A single Main Motor (A) with high peak torque drives the bottom shear knife directly. Speed drops during the cut are overcome in an average of 0.2 seconds—a big factor in cutting accuracy. The only gears in the system are between the bottom and top knives. Fewer gears mean less maintenance, greater reliability.

Power supply for the Main Shear Motor is a d-c generator (B) driven by a synchronous motor.

PILOT GENERATORS AND ROTOTROL SYNCHRONIZE SHEAR WITH MILL

The Shear and Mill are synchronized by two pilot generators, one *geared* to the Shear Motor, the other to the last finishing stand motor (C). The voltage outputs of the two generators are connected to oppose each other. (See diagram.) Thus, when the differential voltage is zero, the Shear and Mill are synchronized.

The voltage differential existing before synchronization is fed into the Rototrol Regulator (D) and the Electronic Regulator (E). They combine to synchronize the Shear and Mill *and* provide infinite speed control within the operating range. They also control acceleration and retardation. The Shear is easily stopped, reset and started as each slab goes through the mill. This cuts scrap loss.

This Shear Drive meets the fundamental requirements. It's simple and reliable, easily regulated, has excellent synchronization and complete speed variation. It saves money, cuts strip more accurately.

SURE WAY

to get

Co-ordinated Auxiliary Drives

Planning a new cold mill? Expanding slabbing capacity? Modernizing your open-hearth shops? Whatever the job, the Auxiliary Drives you choose will have a big effect on its performance.

There's a sure way to get the *intricate co-ordination* needed to develop the "one best" Auxiliary Drive—let Westinghouse handle the job. We've had a tremendous amount of experience with Drives—more than any other manufacturer. We know the problems and how to go about solving them.

Right from the beginning, Westinghouse Steel Mill Specialists consult with you and the equipment builders. Help select the motors, speed reducers, controls and switchgear. Co-ordinate the whole installation. Make the plant layout drawings if you wish. And most important—*stay with the job until it's running just as it's designed to.*

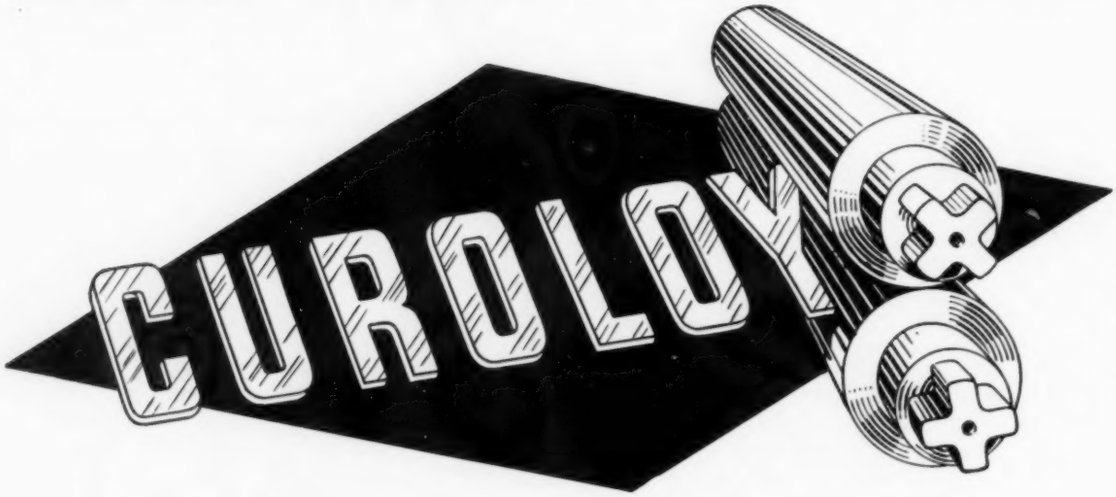
Co-ordinated Auxiliary Drives by Westinghouse are proving themselves in hundreds of steel mill applications. Chances are they're saving power and maintenance and helping turn out superior products in your mill today. When you're planning new capacity or modernizing, get in touch early with your Westinghouse office. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-94814

Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY

For finer FINISHES and LONGER ROLL LIFE



COPPER GRAIN ROLLS

in 4 grades

HARD MEDIUM MILD EXTRA MILD

The patented analysis of Birdsboro "Curoloy" rolls provides the proper combination of physicals to meet a wide variety of service conditions and your specific requirements.

TYPES OF FINISH: Roughing, Semi-Finish and Finish

MATERIALS ROLLED: Mild Alloy and Special Steels
Non-Corrosive Irons and Steels
Non-Ferrous Metal Bars and Shapes

SECTIONS ROLLED:

Rods	Structural
Merchant Bars	Plates
Flats	Strip
	Special Shapes

Put your roll problems into the hands of Birdsboro engineers if you are looking for high, uninterrupted production, greater tonnages and more rolling accuracy.

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ROLLS

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DESIGNERS and BUILDERS OF: Rolls • Crushing Machinery • Steel Mill Machinery • Hydraulic Presses • Steel Castings • Special Machinery

SQUARE D's *New*

SAFETY SWITCHES

***Types A, C and D**

Backed by 40 years' DESIGN LEADERSHIP

The remarkable superiority of this new switch line is reflected in these TYPE A design and operating features:

MODERN STYLING is both functional and attractive.

COMPACTNESS obtained without sacrifice of wiring convenience.

FULL COVER INTERLOCK has attachment that locks switch "ON" or "OFF" with 1, 2, 3 or 4 padlocks of nearly any size or shape.

SIMPLE MECHANISM—quick make-and-break action—no dead center.

SILVER-PLATED current-carrying parts.

EXPOSED BLADES permit visual checks of switch operation.

DEAD-FRONT line terminals are protected by hinged arc chamber cover.

MAGNETIC ARC PLATE adds to unusually high rupturing capacity.

POSITIVE PRESSURE jaws and fuse clips, steel reinforced, silver-plated.

NON-TRACKING insulation used in base. Melamine insulating cross-bar.

REMOVABLE PRESSURE CONNECTORS permit substitution of solder lugs, where preferred.

Types **C and **D** similar to Type **A** in appearance—differ in construction details*

In production: 30 and 60 ampere sizes ...**NOW** · 100 and 200 ampere sizes ...**SOON** · Larger ampere sizes ...**LATER**

Write **for Bulletin 3100 • Square D Company, 6060 Rivard Street, Detroit 11, Michigan**

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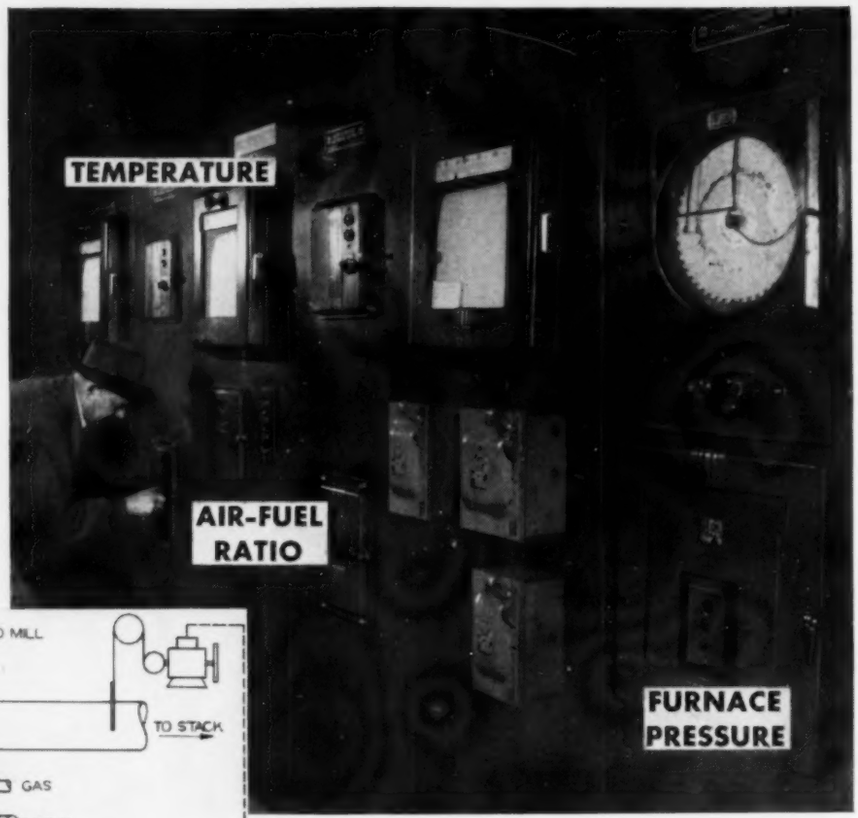
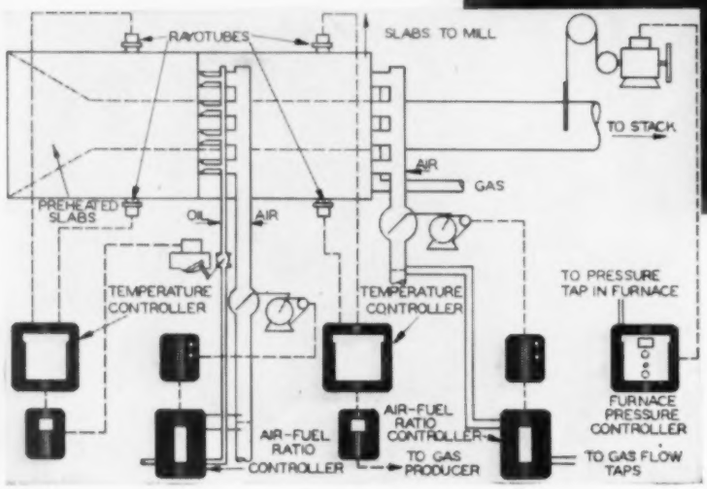
SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

NEWS!
in CONTROL for FURNACES





Typical application of L&N Integrated Control is on slab-heating furnace diagrammed at left. Control panel is shown above. Producer gas is fired in the soak zone, oil in the pre-heat. To assure maximum heating with the cheaper fuel, the L&N Integrated Controls for both zones are interlocked, so that oil supplies only the supplementary heating. Net result of this flexible set-up is top fuel efficiency, and "closer control than we've ever had before".

If you haven't yet investigated L&N Integrated Control for soaking pits and other big furnaces, you may be missing a chance for important savings in operating costs. A big step forward in instrumentation, this new control now gives you all-L&N quality results in coordinating the regulation of temperature, draft and air-fuel ratio. Integrated Control links these vital factors in a completely electric system.

More Production. Mill stoppages for temperature adjustment are virtually ended, because slabs or ingots are fed to the mill at just the right temperature for rolling. Refractories last longer; time between repair shutdowns is increased.

Less Fuel Per Ton. Fuel is burned efficiently at all firing rates under regulation of the new L&N Air-Fuel Ratio Controller. This flexible, sensitive instrument accurately meters combustion air in proportion to gas or oil. Wasteful overheating is eliminated.

Fewer Rejects. Slabs or ingots have the right surface for rolling, because furnace atmosphere is held either oxidizing or reducing as required. Uniform temperature means easier rolling, freedom from cobbles, seams, etc.

A Compact System. Immune to freezing and clogging, the L&N system moves all dampers, air inlet vanes and fuel valves by means of electric-motored drive units. The panel arrives at your plant factory-wired and tested; tailor-assembled to the individual needs of your own furnace.

Catalog. For information on this modern way to regulate big furnaces, write for our new booklet, or better still, ask an L&N engineer to call. Address Leeds & Northrup Company, 4942 Stenton Avenue, Philadelphia 44, Pennsylvania.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

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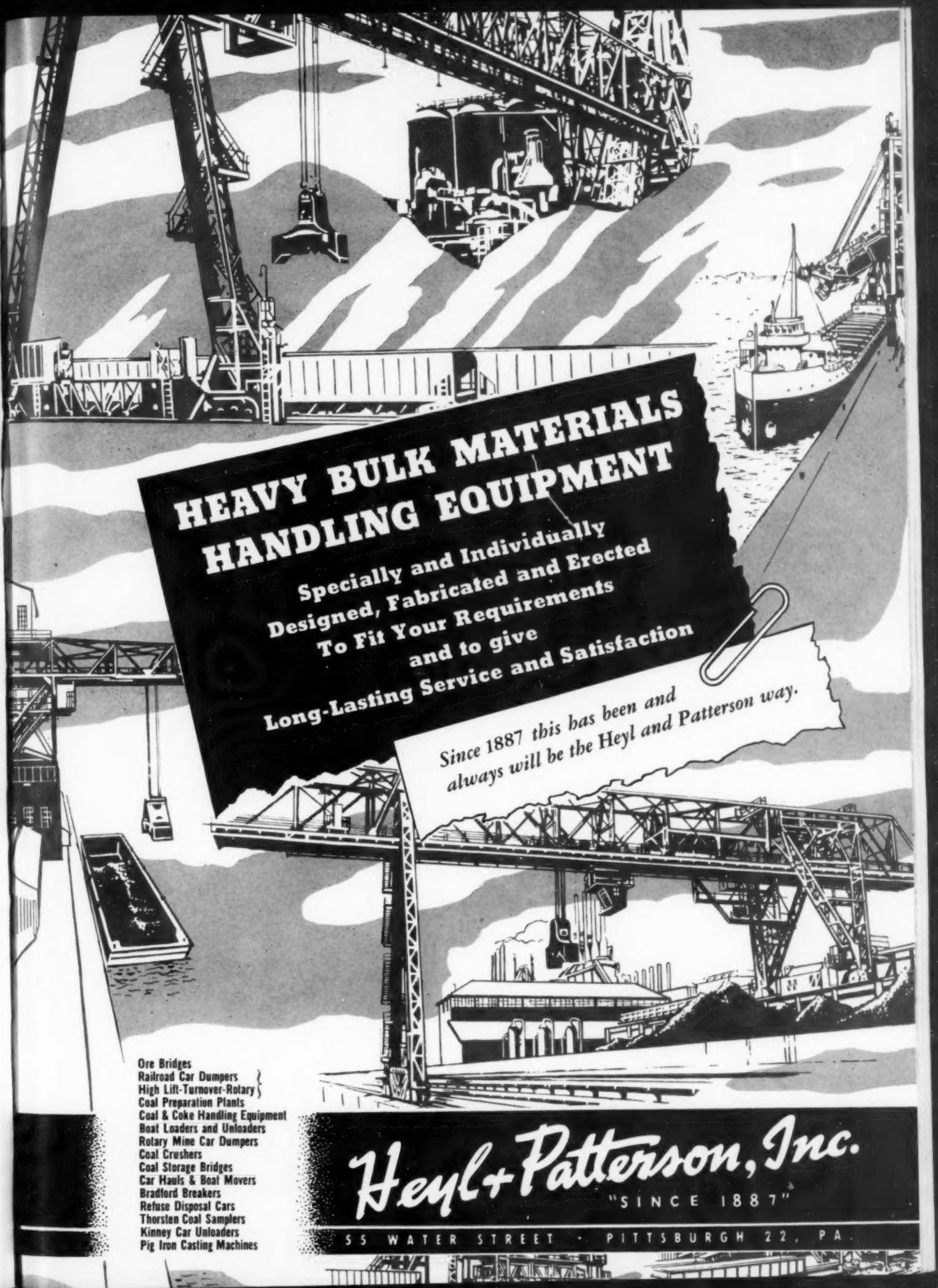
HEAVY BULK MATERIALS HANDLING EQUIPMENT
Specially and Individually Designed, Fabricated and Erected To Fit Your Requirements and to give Long-Lasting Service and Satisfaction
Since 1887 this has been and always will be the Heyl and Patterson way.
Ore Bridges
Railroad Car Dumpers
High Lift-Turnover-Rotary
Coal Preparation Plants
Coal & Coke Handling Equipment
Boat Loaders and Unloaders
Rotary Mine Car Dumpers
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Pig Iron Casting Machines
Heyl + Patterson, Inc.
"SINCE 1887"
55 WATER STREET · PITTSBURGH 22, PA.

Well over 300,000 miles of highway could have been paved with the strip produced by America's steel mills last year. Phoenix Rolls played an important part in this amazing record.

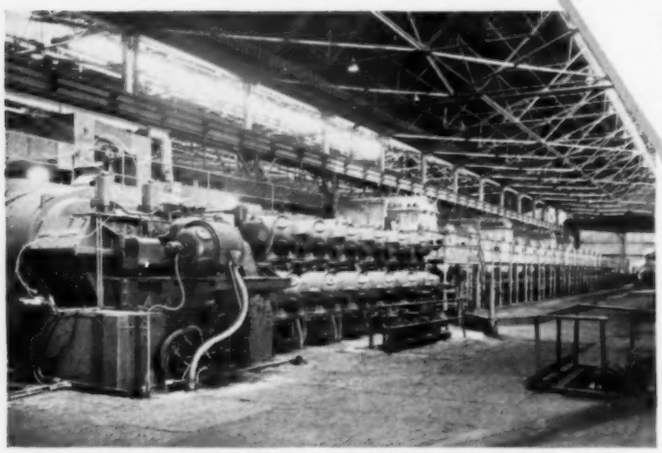
Pittsburgh Rolls Alloy Iron *Work Rolls* and Alloy Steel *Back-up Rolls* in four-high strip mills are rolling steel, aluminum, brass, copper, and magnesium, and are successfully producing flat-rolled products *at less cost per ton of steel rolled.*

PITTSBURGH ROLLS • Division of Blaw-Knox Company • Pittsburgh 1, Pa.

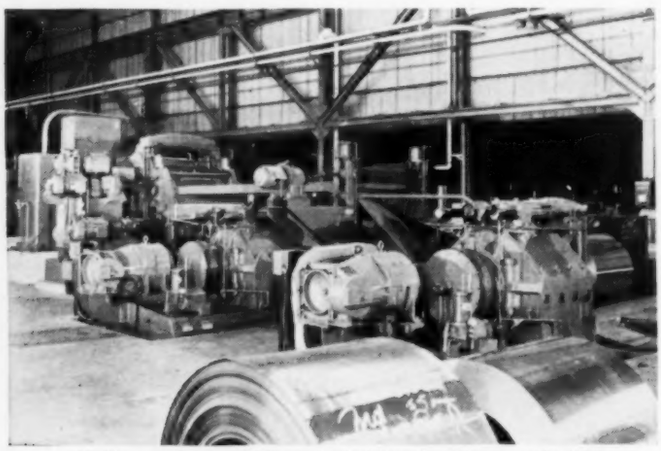
PITTSBURGH ROLLS

RELIANCE ELECTRIC AND ENGINEERING COMPANY

"Know-How"



Reliance-powered High-speed Tube Mill—using over 70 Reliance motors and Reliance VSR electronic speed regulation on saw synchronization.



Reliance-powered Electrolytic Tinning Line—with Reliance VSA tension control regulators and three inter-related adjustable-voltage V★S systems.

Reliance-powered Tin Plate Shearing Line—Close coordination of motors provides smooth acceleration and high production speeds.

. . . GAINED IN OVER 40 YEARS OF STEEL MILL EXPERIENCE . . . Assures the smooth, synchronized, continuous-flow operation of high-speed processing lines for maximum efficiency

Often the margin of profit in today's highly competitive markets is tied directly to the rate and continuity of production. Modern, automatic, high-speed machines and their precision-engineered motor drives provide the top speeds and continuous operation necessary to keep the various components in step through all variations in speeds and tensions.

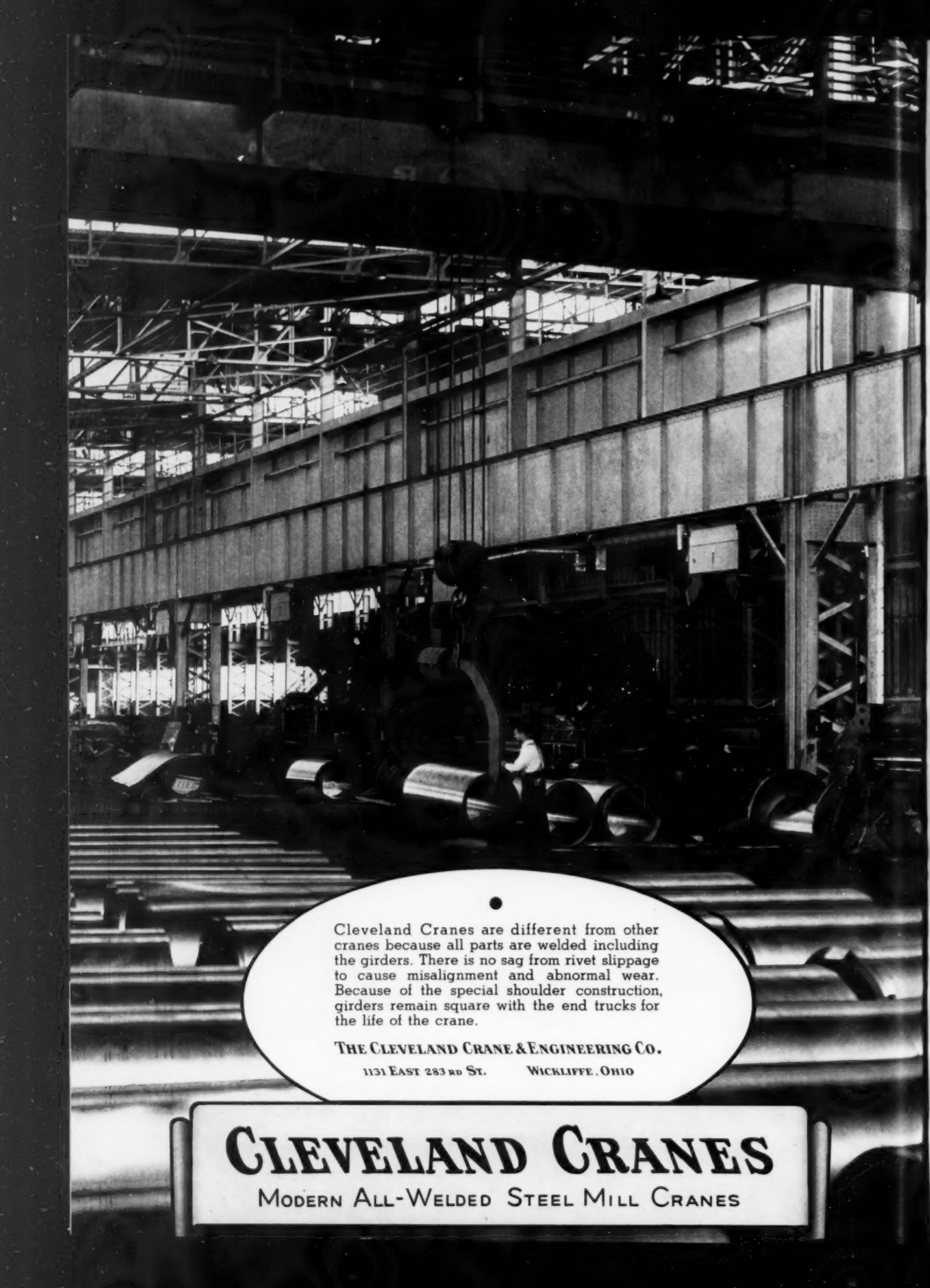
Mills and processing lines, powered by the Reliance V★S System, offer convincing proof of Reliance "know-how" in their smooth, fast, continuous-flow output . . . and in the satisfactory profit margin which results from such efficient operation. While your plans are still in the blueprint stage, it will pay you to check *first* with a Reliance application engineer.

RELIANCE V★S SYSTEM

Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"Motor-Drive is More Than Power" • 1084 Ivanhoe Road, Cleveland 10, Ohio



Cleveland Cranes are different from other cranes because all parts are welded including the girders. There is no sag from rivet slippage to cause misalignment and abnormal wear. Because of the special shoulder construction, girders remain square with the end trucks for the life of the crane.

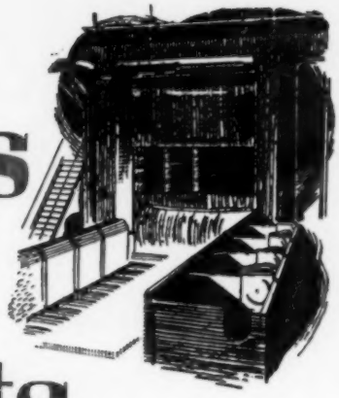
THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts



BEFORE the steel strike was four weeks old, quite a number of steel companies had cut salaries in various degrees, ranging from 20 or 30 per cent for men actually working up to complete lay-off. There are only two reasons why salaries should be affected: first, lack of money to pay them, and second, the desire to increase pressure for settlement of the strike. The first reason was almost non-existent in the early weeks of any strike in recent years. The second reason is a short-sighted, poorly advised policy which may back-fire in several ways.

Salaried personnel — particularly supervisors — have always been considered "company men." Indeed, they must be, if plants are to be operated smoothly and efficiently. Salary used to be a badge of distinction, and implied loyalty to company policies. But over the past 10 or 15 years, some managements have taken advantage of this to a point of actually discriminating against their supervisory men, knowing that these men cannot complain too loudly without damaging their own careers.

The depression and the strikes of the thirties resulted in much "sour" supervision — more than most managements realized. During recent years, many supervisors have shown a trend of thought by stating that the only raises they received came as a result of general wage boosts brought about by unions. All of this is bad — and entirely unnecessary.

Top management must make up its mind whether or not it wants its salaried personnel to be "company men," and then treat them accordingly. This lesson should have been learned thoroughly, but it would seem that we are again starting through the same cycle.

▲

A READER hands us this definition: Poverty is a miserable state of existence that deprives one of many things he is better off without.

▲

THE metallurgical fraternity is highly excited over the possibilities of titanium, which is said to be as strong as stainless steel but weighs 40 per cent less and is more resistant to corrosion. So far, its cost is high — about $5 per pound for the cast metal and $20 per pound for sheet — because it is difficult to produce. At its melting point, titanium oxidizes rapidly, and must therefore be produced under a vacuum or in an atmosphere of inert gas. E. I. du Pont de Nemours and Co. has been operating a pilot plant on an experimental basis, and Allegheny Ludlum Steel Corp. recently announced its entrance into the field. Allegheny Ludlum is producing 100 lb ingots in an electric arc process, and is building another furnace at Watervliet, N. Y., to produce 500 lb ingots.

▲

MOTOR vehicle registrations in the United States now total more than 41,000,000, exceeding the prewar peak of 1941 by more than 18 per cent. During 1948, motor vehicles in the nation covered 400,000,000,000 miles.

▲

AT the risk of having Phillip Murray adopt the idea as the next plank in his platform, we feel we must pass on the pension plan outlined in a recent Wall Street Journal editorial:

Retire at Birth

All the pension plans we've heard about recently strike us as woefully inadequate compared to one dug up by Alfred Haake, who besides being mayor of Park Ridge, Ill., writes for a number of small town newspapers.

"Every new-born child in the United States would receive a promissory note for $20,000 at 3 per cent interest, payable in 20 years. The 3 per cent, or $50 a month, would go to the child's parents until the child was twenty. Each year during those twenty the government would pay $1,000 into a sinking fund for the retirement of the note and when the child reached the age of twenty the government would give him or her the $20,000 it had paid into the sinking fund.

"Boys and girls of twenty who elected to marry would thus have a capital of $40,000 and work would be forever unnecessary if they would undertake to have at least four children, because they would receive $50 a month for each child until it reached the age of twenty, and there would be enough left of their own $40,000 after that to care for them in their old age.

"Nobody would have to work again. The plan would cost only $1,600 ($600 interest plus $1,000 for retirement) . . .

"The parents, in addition to the $50 for each child, or $200 a month for four children, could invest their $40,000 in government bonds at 3 per cent and have an additional income of $100, or a total of $300 a month."

This might seem comical. But in a day when the government proposes to make us all rich by distributing dollar bills and when a labor union says we can all have more good things by working less, we wouldn't be surprised to see this scheme taken up seriously in Washington.

The project for the new era will be to work less and less and quit even that earlier and earlier. The slogan: "Why Wait. Retire at Birth."

▲

CHARLES P. KETTERING, former head of General Motors research, is the source of many a bon mot:

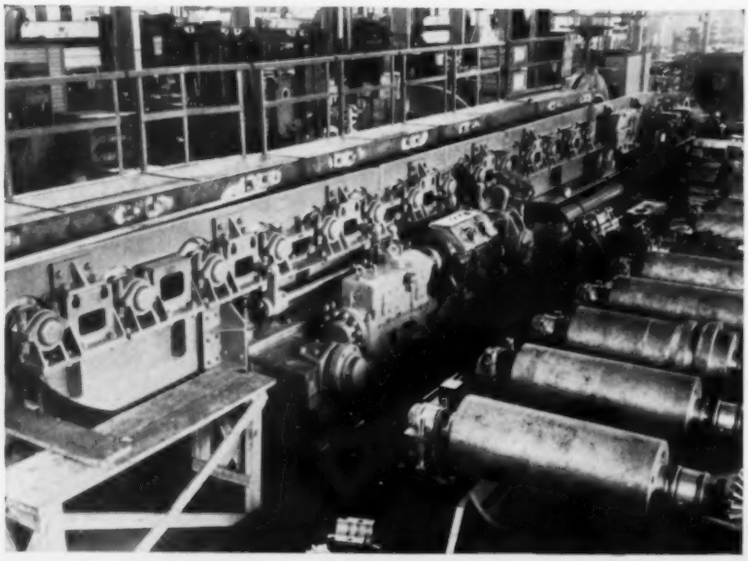
"People are very open-minded about new things, so long as they're exactly like the old ones."

"Research is an organized method for keeping you reasonably dissatisfied with what you have."

▲

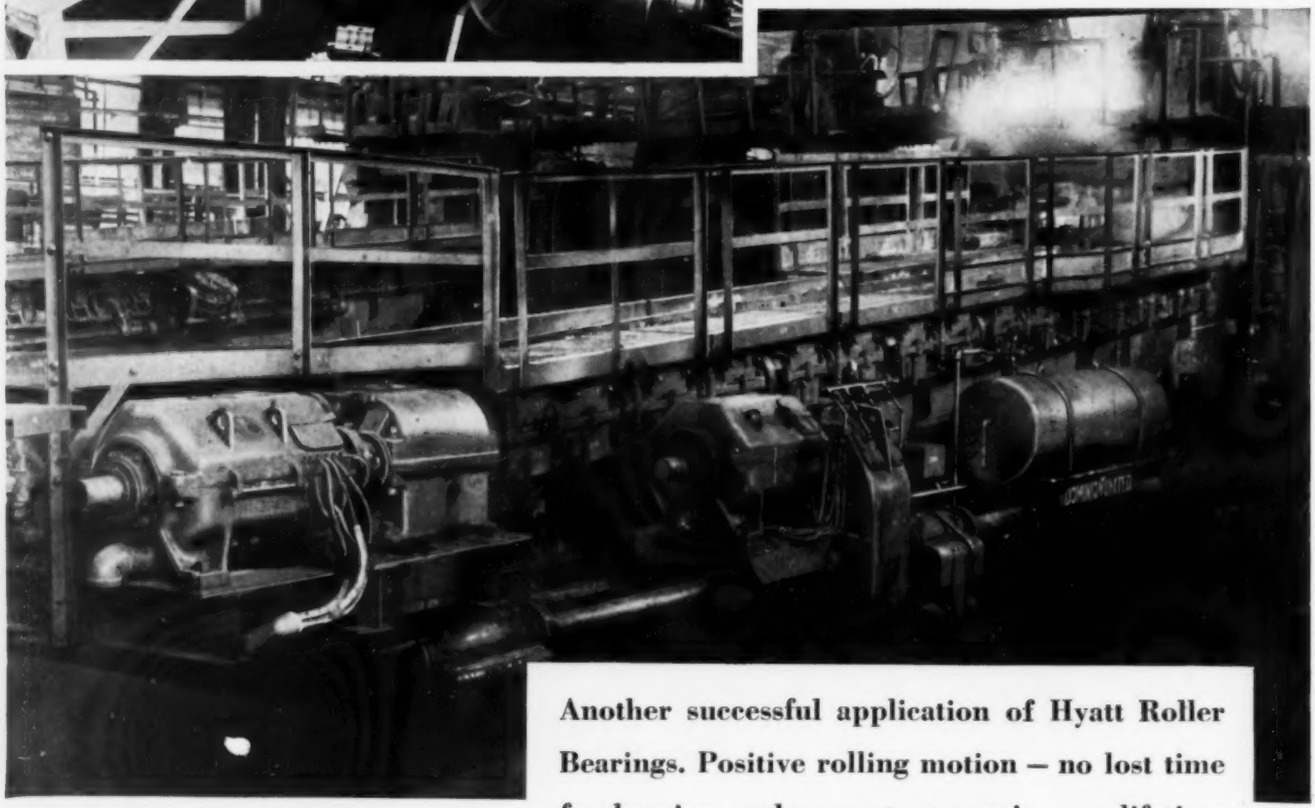
BUSINESS is what, if you haven't got any, you go out of.

Dominion Engineering Built for Algoma Steel

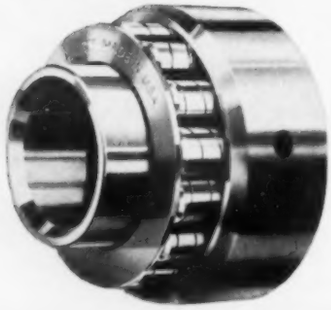


Hyatt Roller Bearings are used on both table roll journals and the lineshaft of the Traveling Tilt Tables at Algoma Steel in Sault Ste. Marie, Ontario.

Left: Under construction at Dominion Engineering Works, Lachine, Quebec, and now in use at Algoma Steel rail and structural mill as shown below.



Another successful application of Hyatt Roller Bearings. Positive rolling motion — no lost time for bearing replacement or repair . . . a lifetime of performance.



In cranes, cars, motors, and other auxiliary equipment, too, Hyatt Roller Bearings are serving equally as well. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

FOR *Constant* CONTACT FROM CONDUCTOR TO CRANE

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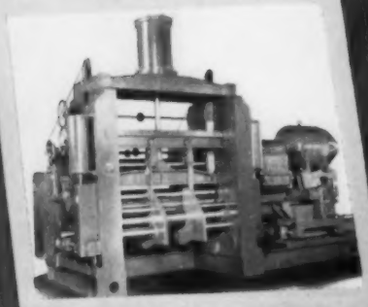

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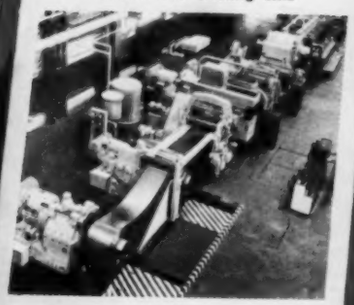

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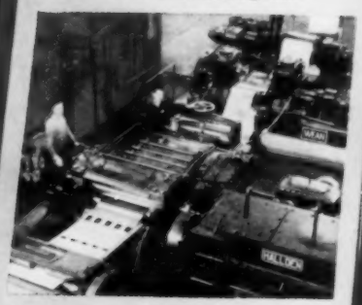

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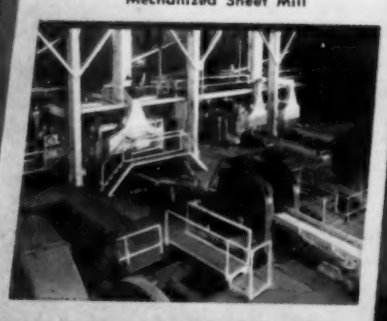

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In This Issue

D-c Drives on Runout Tables and Coilers — by I. N. Tull, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio 53

Controlling and Measuring Steel Temperatures in Billet Heating Furnaces — by Fred S. Bloom, Bloom Engineering Co., Inc., Pittsburgh, Pa..... 60

A Four-High Reversing Cold Strip Mill — by Lloyd L. Wilson, Engineering Consultant, Cold Metal Products Co., Youngstown, Ohio..... 71

Electrical Features of Four-High Reversing Cold Strip Mill — by J. S. Apperson, III, General Electric Co., Cleveland, Ohio..... 76

Training Men at Bethlehem Steel Co. — by H. C. Houghton, Assistant to Manager of Personnel, Bethlehem Steel Co., Bethlehem, Pa..... 81

Training Men at Republic Steel Corp. — by Joseph S. Kopas, Training Counselor, Republic Steel Corp., Cleveland, Ohio..... 84

Scrap Preparation — by R. F. Fien, Ford Motor Co., Dearborn, Mich..... 86

A New Type Soaking Pit Ingot Buggy — by S. H. Mumma, Assistant Superintendent, Electrical Department, Bethlehem Steel Co., Steelton, Pa... 89

Modernization of the Steelton Blooming Mill — by Russell M. Weigle, Assistant Superintendent of Rolling Mills, Bethlehem Steel Co., Steelton, Pa. 97

A. H. Arbogast Wins AISE Award..... 103

High Speed Electro-Hydraulic Arc Furnace Control — by Aage Garde, Research Laboratory, Allmanna Svenska Elektriska Aktiebolaget, Vasteras, Sweden..... 104

Taconite Beneficiation Plants..... 109

AISE District Secretaries 1949-1950..... 112

World's Largest Underground Coal Preparation Plant — by A. J. Morrison, Dravo Corp..... 113

Publication Service..... 117

Date Line Diary..... 125

Industry News..... 129

Personnel News..... 137

Equipment News..... 153

Index to Advertisers..... 167

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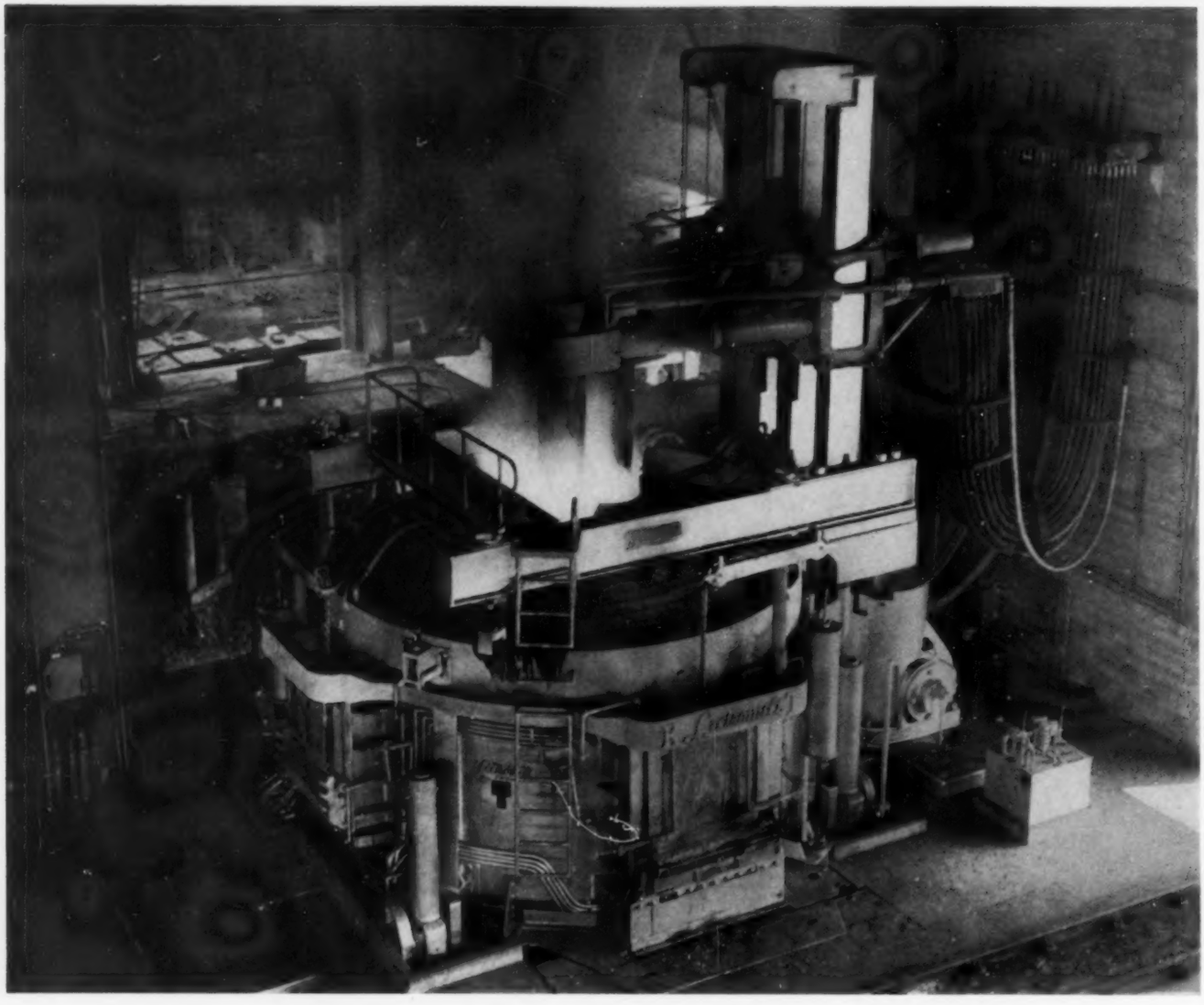

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D-C DRIVES ON RUNOUT TABLES AND COILERS

By I. N. TULL
Electrical Superintendent
Republic Steel Corp.
Cleveland, Ohio

. . . . the decision to use d-c mill motors on runout tables has been proved wise and economical by the records of eleven years' actual operation . . . .

▲ IN the month of October, 1937, Republic put into operation its 98 in. hot strip mill in Cleveland. Its runout table rollers from finishing stand to coilers and piler, and the coiler rolls were the first to be driven by individual d-c motors, and they were controlled by the Ward-Leonard system.

This design was a major departure from the long established use of squirrel cage induction motors supplied with variable frequency and voltage from d-c motor driven alternator sets, and consequently considerable investigation was necessary before the decision was reached by Republic to install the d-c system.

The induction motor application to these mills goes back to 1911, when the Sharon Steel Hoop Co. installed a small mill and equipped one of its roller tables with fractional horsepower polyphase squirrel cage motors running on constant frequency and voltage and consequently at constant speed. The duty was light, and the installation a pronounced success over old methods up to that time of bevel gear group drives and endless belt drives.

The first large application of the same individual type of drive was made in 1919 at the plant of the Interstate Iron and Steel Co., Chicago., this plant now being a unit of the South Chicago District of Republic Steel Corp. This installation differed from the Sharon job, in that variation in speed was necessary to handle products of different sections from the mill, but induction motors were used, supplied with variable frequency and voltage from a d-c–a-c motor-generator set having a range of 15 to 40 cycles, giving a speed range of 2.6 to 1. The d-c motor of the set operated from the shop supply of 230 volts.

Following the Chicago installation, a number of merchant bar mills were similarly equipped, some with as many as 200 motors. Most of these jobs required only about ¾-hp motors, though due to the speed range, the frame size was equivalent to a 3-hp 60 cycle motor at 720 rpm, while the d-c generators supplying them would range from 50 to 175 kva.

The duty cycle on these merchant mill installations was not difficult to meet, as the tables usually were started up at the beginning of a week and adjusted to the mill's speed, running for hours at a time at some set speed. As orders on the mill changed section and speed requirements, the motor driving the alternator would be speeded up or down by shunt field adjustment.

As long as the tables were small, this arrangement was without doubt the simplest and best. The a-c motors were perfectly suited for such service, not calling for frequent starting and stopping. Also, the quantity of power involved was small and the obvious gains overbalanced the lack of efficiency of double conversion from a-c supply to d-c, then from d-c to a-c through the adjustable speed motor-generator.

Tables and coilers of a modern wide strip mill present an entirely different problem. The coilers are started and stopped for each coil, and the rates of acceleration and deceleration are of necessity quite high. The tables also have to be accelerated and decelerated quickly to meet the high delivery speeds of the mill, and sometimes it is necessary to enter the strip at low speed to the coiler, even though the mill is delivering at full speed. When the mill is rolling plate, it is often required to stop the steel on the table very quickly in order to remove it broadside to transfer tables, and then to start the table again quickly enough to take the following piece from the mill.

In general, for frequent starting, stopping and reversing duty throughout the steel industry, mill duty direct current motors are specified, but due to the slow growth of the runout table sizes, the induction motor drive grew in size, until the rollers had grown in inertia from WR^2 values of 3 or 4 to over 200.

At the time of negotiations for equipment to operate the Republic 98 in. strip mill, the use of d-c motors for

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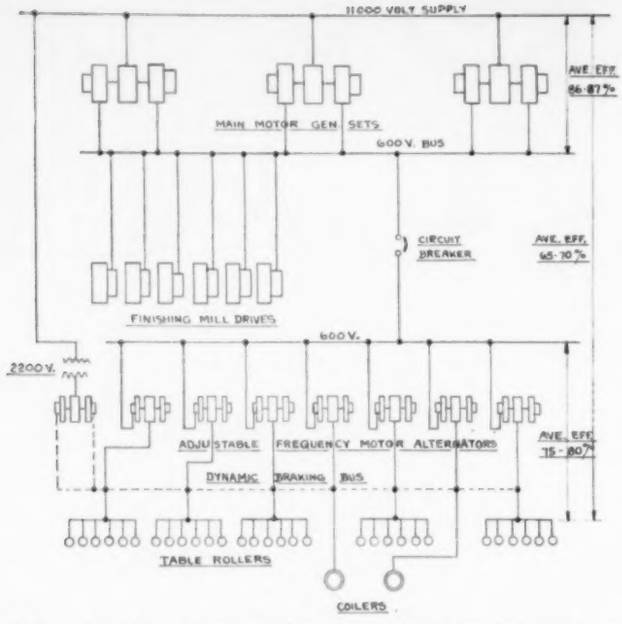
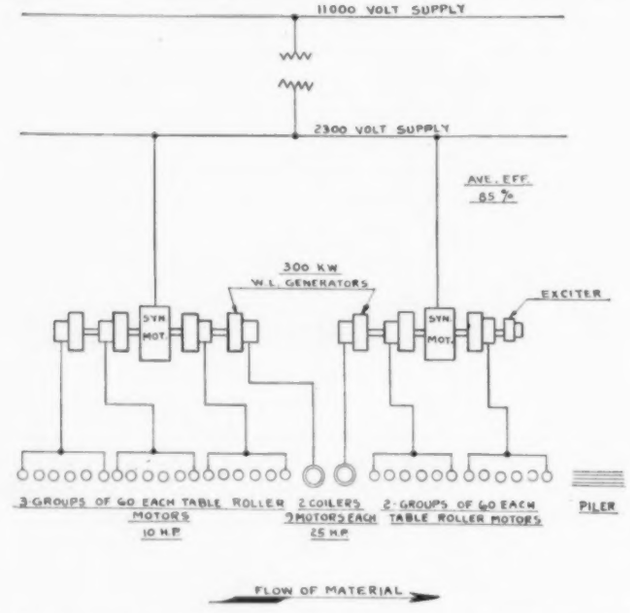


Figure 1 — Line diagram for a-c roller table installation.

Figure 2 — Line diagram for d-c roller table installation.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2300 VOLT SUPPLY
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EXCITER
SYN MOT.
SYN MOT.
3 GROUPS OF 60 EACH TABLE ROLLER MOTORS 10 H.P.
2 COILERS 2 MOTORS EACH 25 H.P.
2 GROUPS OF 60 EACH TABLE ROLLER MOTORS
PILER
FLOW OF MATERIAL

the runout tables and coilers was suggested to the writer. As something over $250,000 (at that time) was involved for this part of the Republic mill, we felt the matter well worth going into, and a study was made of the merits of the case on a basis of performance, reliability, efficiency, maintenance costs and investment.

The mill arrangement called for a table of five sections of 60 rollers each, and two coilers of 9 rollers each, the sections and coilers to be individually controlled. The rollers were to be 12 x 98 in., the top surface speed was to be approximately 2,300 fpm. The acceleration from rest to maximum speed was required in 6 seconds, deceleration the same, and from maximum speed forward to maximum speed reverse, 13 seconds.

For driving the five table sections and two coilers, with induction motors, a total of seven motor-alternator sets and one motor-generator set to furnish dynamic braking current would be required.

The line diagram, Figure 1, shows such a system. Power supply is 11,000-v, 3-phase, 60-cycles. The three main 6000-kw, 600-v motor-generator sets for supporting the finishing mill stands feed also the motor-alternator sets through a circuit breaker. Starting and speed controlling devices are not shown to avoid complexity.

To obtain adjustable frequency, the motor-alternators must be adjustable speed, and due to the wide range required in short time cycles, inertia must be reduced to a minimum. Accordingly, in sets of the size required for this job, three unit design is used, the d-c motor being split in two and connected in series across the 600-v bus. This makes for smaller diameter armatures and consequently lower WR^2. In addition, it gives the desirable lower voltage commutators.

The dynamic braking set is shown at the left. Its function is to supply low voltage d-c to the various groups of induction motors for quick stopping. It is a constant speed set of 300-kw rating, having a voltage a little higher than necessary to force load, and a half current through the induction motor windings, after they have been disconnected from the alternator sets.

The average efficiency of the main sets is around 87 per cent as shown, while due to smaller size (520 kva) and characteristics, the alternator sets have only an operating efficiency of 75 to 80 per cent. Accordingly, the overall efficiency of the system is about 65-70 per cent.

The control apparatus for this particular requirement would be made up of magnetic contactors mounted on panels similar to conventional industrial control. The space required is 75 ft by 9 ft, while that for the sets is 75 ft by 25 ft. The width of the building having been established, the control and sets take up an area of 75 x 65 ft.

If the tables and coilers are equipped with d-c motors rather than a-c, and Ward-Leonard control is used, then a system such as that shown in Figure 2 results. Here we have only two motor-generator sets for the tables and coilers instead of eight. The sets are constant speed, driven by 1250-hp, synchronous motors, one set having four generators, the other one three duplicates, and one exciter, for all the motor fields. The length of control panels is 30 ft, and both motor-generator sets can be

Figure 3 — The runout table consists of 300—12 x 98 in. rollers, each driven by a d-c mill motor, having 30 lb-ft continuous torque, 750-rpm, 250-v. Motor protective breakers are mounted in steel cases at motors with two breakers per case.

accommodated in a space 30 x 65 ft. The saving in building space amounts to about 3000 sq ft, which at five dollars shows a reduction of $15,000 allotted to building cost.

The synchronous sets are supplied with 2200-v current and started at full voltage. Note the elimination of double conversion and consequent improved overall efficiency from a maximum of 70 to an average of 85 per cent. The average power consumption of several a-c installations of comparable arrangement and size is 4 kwhr per ton of steel rolled. For round figures, a production of 100,000 tons monthly at 4 kwhr per ton means 4,800,000 kwhr of purchased energy is to be considered yearly. At seven mills, this amounts to nearly $34,000 and consequently is subject to close scrutiny for possible savings.

It was estimated that the proposed d-c motor appli-

Figure 4 — After the original installation, the motors and spindles were later moved to the opposite side of the table from the original location.

cation would lower the energy consumption to 3 kwhr per ton or an annual saving of $8500. Actually, the average kwhr used is 2.6 per ton.

Besides the better efficiency of the d-c conversion system, the efficiency of the individual motors had to be investigated and compared. For an analysis of this comparison, L. A. Umansky's paper, "Direct Current Drives for Runout Tables and Coilers," published in the 1938 Proceedings AISE, p 186, shows very clearly the distinct advantages inherent in the operating characteristics of the d-c motor over that of the induction motor for the service required.

There was the accelerating and decelerating loss of the variable frequency motor-alternators to consider. Their WR^2 is considerable and possibly would amount

Figure 5 — The hot strip coiler is driven by 9 shunt-wound, 25-hp, 700-rpm, 250-v, d-c mill motors. An air operated coil pusher is shown in the foreground. The table rollers over the coilers are each driven by 30 lb-ft, 750-rpm, 250-v motors.

to one-fourth as much as their connected loads. The constant speed Ward-Leonard set has no such loss to contend with, as it only accelerates when started on the mill schedule, usually once a week, running steadily at constant speed, the running light losses being much less than the losses due to accelerating and decelerating of the variable frequency system.

In comparing the two systems, the number of units in the case of the motor-generators showed a reduction from eight to two. The two synchronous motor-generator sets for the Ward-Leonard system need a total of two motors, seven generators and one exciter to do the job that eight alternator sets of three machines each or a total of twenty-four machines are called for in the induction motor case.

The difference in efficiency and the lower number of machines means that less ventilating equipment will be required for the Ward-Leonard system. As a matter of fact, there was actually a lower cost of this equipment by about $4,000.

One of the reasons originally for using induction motors on runout tables was the fact that a group running from a common source of energy with about the same average load, would all run at the same speed, and there would be no appreciable slippage between rollers and strip carried by them. This was so until speeds below the "falling out of step" voltage were reached, and this was somewhere under 40 per cent top speed.

At first thought, a group of d-c motors would be open to suspicion that they would not run closely enough together to be free from slippage troubles. With properly adjusted fields, air gaps and brush position, it was felt that shunt wound motors would synchronize as well as induction motors, and this proved to be the case. In fact, at low speeds, the d-c motors on the Ward-Leonard system stick closer together and are far more responsive than the induction motors.

Removing the table and coiler loads from the 600-v generator bus will relieve capacity usually needed for the mill proper. The 600-v generating capacity for the finishing end of Republic's 98 in. hot mill is 18,000 kw, and the swings for the tables and coiler loads were expected to be up to 2000 kw or 11 per cent of the capacity, and these swings usually come at the same time that the mill pulls its heaviest. Some mills have had to bolster their 600-v generator equipment on account of the ever mounting load requirements, and certainly if removing the table and coiler drive from this source could be accomplished without excessive cost it should

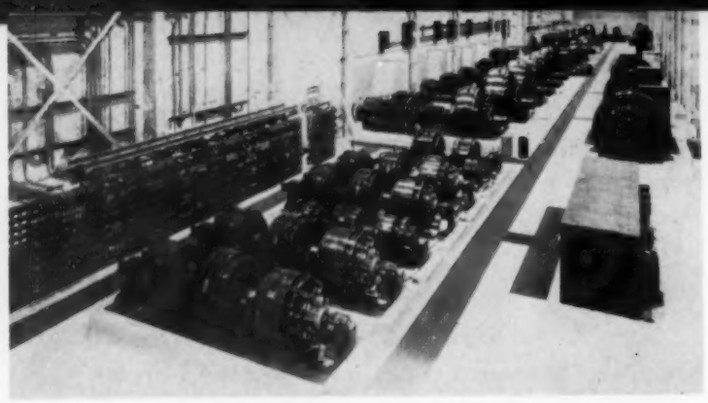
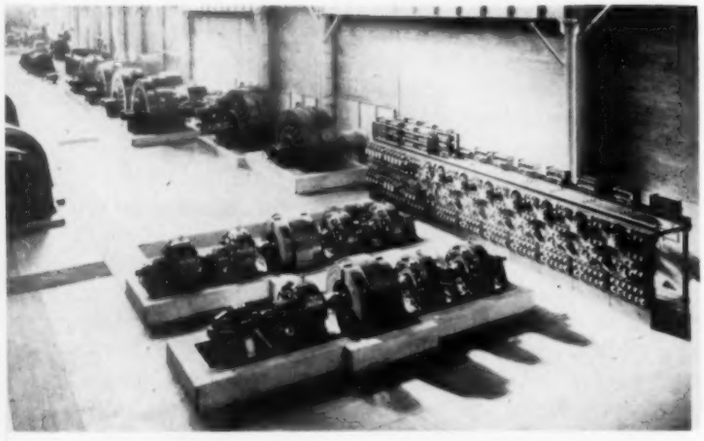


Figure 6 — General view of an older wide strip mill motor room, which uses induction motors for individually driving runout and coiler rolls. The motor generators and control are shown in the forecenter and at left respectively. The main drive motor and generator sets are shown in the background and the high voltage switch gear is shown at the front right.

Figure 7 — This figure should be compared with Figure 6. This is a general view of the motor room from the finishing end showing two motor-generator sets and coilers in the foreground. One 3500-hp and five 4500-hp, d-c motors which drive finishing stands are at the right, and are supplied with power from the 6000-kw motor-generator sets at the left.



be done. Every kilowatt available for the mill has been needed and used a good many times.

The circuit breaker shown in Figure 1 between the 600-v bus and the motor alternators has to be of high interrupting capacity, as the d-c bus at times of short circuit may have as high as 700,000 amp in it, and the breaker must be able to interrupt that much current without distress. The cost of such a breaker installed was about $5,000. It is not needed with the Ward-Leonard system, as each generator has a rating of only 300 kw, and the short circuit current can only amount to around 25,000 amp.

A d-c motor naturally costs more than a squirrel cage induction motor, but eight three-unit motor generator sets cost much more than two, when the units are of comparable size and speed. In this case, the difference in first cost was about $35,000.

A reduction in conduit and wiring cost because of the fewer control panels needed for the Ward-Leonard control reduced that part of the estimate by about $11,000.

The next items to consider are reliability and cost of maintenance. Provided the d-c motor is built in line with mill type construction, its reliability when properly installed is beyond question, it having demonstrated its long freedom from trouble for a good many years, and that includes commutation under tremendous overloads. Besides its commutator, the only other wearing parts not found in a squirrel cage induction motor are the brushes. Investigating the possibility of costly brush replacements, we found that while the d-c system required a total of 1636 brushes to equip all motors and generators, the a-c system required 768 on account of the large number required for the motor-alternator sets. If all the brushes had to be replaced once a year on both systems, there would only be $300 in favor of the a-c system, because of the larger relative number of large brushes used on the a-c system sets.

One of the most consistent criticisms from the opponents of the d-c was about this question of brushes. Some felt that the maintenance due to the presence of brushes and commutators would be prohibitive.

Here is the record, including spares after 11 years of service:

300—Table motors equipped with 1200 brushes, ½ x 1 x 2 in., of these 274 were replaced.

20—Coiler motors equipped with 80 brushes, ⅝ x 2¼ x 2½ in., of these 74 were replaced.

7—Generators and 1 exciter equipped with 356 brushes, 1 x 1¼ x 2½ in., of these 1412 were replaced.

It is believed that the higher replacements of the generator brushes is due to the higher angular and surface speeds of the commutators, the table and coiler motor speeds being 750 rpm top, surface about 1300 fpm, while the generators run at 1200 rpm and 5000 fpm. The tables and coilers run intermittently and probably at an average speed of 525 rpm and 900 fpm.

There have been no commutators replaced, 9 having been repaired.

There have been 5 sets of field coils in the table motors replaced.

There have been 24 table armatures and 3 coiler armatures rewound.

There have been 2 generator main fields repaired because of grounds.

Both synchronous motor fields were removed, cleaned and reinsulated in the spring of 1948.

Both synchronous motor stators were rewound in the spring and summer of 1948. The reason for the rewinding was due to oil leakage from their own bearings and vapors from adjacent air compressors weakening the insulation enough to cause one winding to fail; the other was rewound to prevent failure.

Three table motor shafts have been replaced on account of being broken.

Six coiler motor shafts have been bent and straightened. These motors had actually, by reason of broken supporting brackets, fallen several feet, and even though they weigh about 2000 lb, were in operating condition after the shafts were straightened and new bearings installed.

As originally installed, the three groups of table motors between mill and coilers were mounted on the aisle side of the mill, that is, on the side where cobbles were pulled. Consequently, much damage was done the sheet metal boxes housing the individual protection breakers and wiring. In addition to that trouble, the 98 x 12 in.

rollers weighing about 2500 lb, upon becoming distorted from heat and binding in the table apron plates, would from unbalance, vibrate and cause the mill bearings to wear, in turn throwing the weight and twist onto the motor bearings through the couplings. As neither the motor bearings or couplings were designed for such abuse, considerable trouble was encountered and about five years ago the motors were moved to the opposite side of the table. Figure 3 shows the original installation of the table motors and individual circuit breaker cases.

This move accomplished two things. It took the protection boxes out of the way of cobble pulling, and enabled the motors to be moved out two ft from the table so that a spindle two ft long could be interposed between the roller and motor coupling. This two ft spindle, connected at each end by means of a flexible coupling, allows considerable misalinement between the roller and motor and relieves the motor bearings from the punishment previously received from the short coupled arrangement. Figure 4 shows the arrangement after the motors and cases were moved and the spacing spindles added. Figure 5 is a view of one of the coilers with its motors.

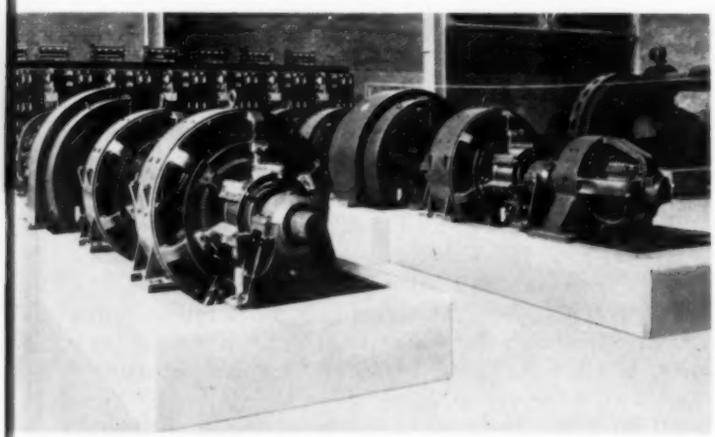
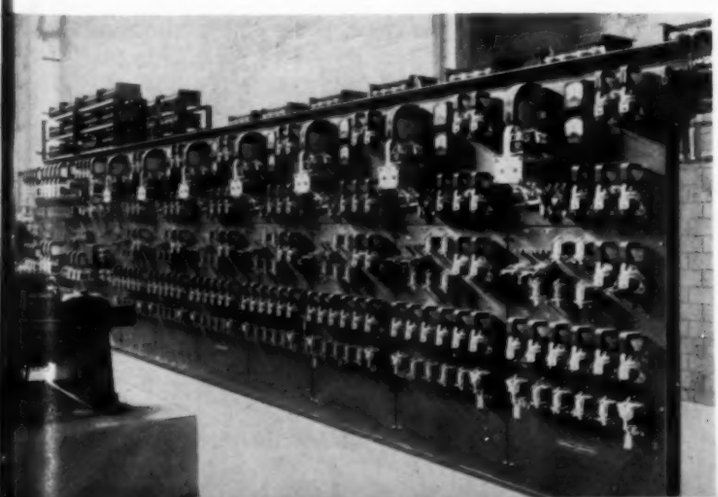


Figure 8 — Shown in the photograph are the motor-generator sets for the runout tables and coilers. The set in the front consists of a 1250-hp, 1200-rpm, 2200-v synchronous motor driving four 300-kw, 250-v, d-c generators. The second set consists of a double synchronous motor, three 300-kw generators and a 60-kw, 125-v exciter. The control panels are in the background.

Figure 9 — Control board for runout tables, coilers and flying shear.



The damage from the causes above cited caused the following replacements:

646—No. 2 couplings.
73—No. 309 ball bearings.
120—No. 311 ball bearings.
36—Coiler motor No. 3 couplings were changed.
36—Coiler motor No. 22315 bearings.

Since the change was made on the three sections of table motors, both couplings and bearings have shown a marked decrease of trouble from mechanical damage, but water still causes much coupling and bearing damage. A great deal of damage to rollers, apron plates, motors, and bearings has been done by the use of large lifting magnets handled by crane hooks. A 65 in. round magnet weighs nearly 5 tons and no craneman can become expert enough to swing such a magnet in the proximity of a roller table without doing damage. The use of magnets should be discouraged for such purposes, and tongs, come-alongs, etc., should be developed to accomplish what is needed.

Another source of trouble has been spray water. Nowadays to meet requirements, the metallurgist has to call for many times the water quench that he used to feel satisfied his needs. The tables in few cases have been modified to protect the electrical equipment from water damage and this problem has to be met. In our case, we are putting additional plates between the side of the tables and our motors and breaker boxes, but we are not out of the woods yet.

The troubles we have had along the lines above have, we understand, been paralleled in other mills, and in one case V-belt drives have been substituted with good results. This was applied to an a-c job, so that whether the job is a-c or d-c, there are troubles common to both, having no relation to the type of motor used whatsoever.

As to investment, the following items of first cost were decisive and conservative:

D-c Ward-Leonard saving over conventional a-c:

Motors, sets and control	$35,000
Building space	15,000
Foundations	5,000
Circuit breaker omission	5,000
Ventilating equipment	4,000
Conduit and wiring	11,000
Total savings in first cost (1937)	$75,000

Energy cost savings as noted in an earlier paragraph amount to considerably more than the $8500 estimated annually, in fact to over $11,000.

Troubles have not been caused by commutators, brushes or any other part inherent to d-c design, so we feel that our installation has more than justified our judgment in deciding to accept the new drive.

Not every job can be expected to justify a d-c Ward-Leonard installation. Each must be analyzed on its own merits. The balance between the number of groups of motors and sets will tell most of the story.

Figures 6 and 7 show strikingly the difference in sets and control of comparable size installations. The a-c control has to handle very heavy currents and the contactor repairs and replacements are heavy. The Ward-Leonard, handling only field currents of from 2 to 20 amperes, with 100 ampere contactors, requires a mini-

mum of attention and expense. Figure 8 is a close-up of d-c sets and control, while Figure 9 is a close-up of the d-c control panels seen in the rear of Figure 8.

For conclusion, we would do the electrical job today the same way, although we would provide better protection against water and shifting alinement between motors and rollers. Perhaps soon, perhaps a long time off, a better way of supplying variable, adjustable speed to meet the conditions of operation of hot steel conveyors will be found, and we will be as glad to utilize that new method as we have been to use what is now the old.

DISCUSSION

PRESENTED BY

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J. R. ERBE, Industry Engineering Department, Westinghouse Electric Corp., Pittsburgh, Pa.

R. A. GEUDER, Manager, Applied Engineering Department, Reliance Electric & Engineering Co., Cleveland, Ohio

I. N. TULL, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio

W. B. Snyder: Mr. Tull's paper is an excellent example of how to make an engineering study, and how the conclusions have been more than justified by operating results. The soundness of these conclusions has since been demonstrated on several other installations. Following the 98 in. mill at Republic, there were four other hot strip mills purchased in 1937. Two of these use mill type d-c table and coiler motors similar to those on the 98 in. mill, and the other two use a-c motors. To the best of my knowledge, there has been no later installations of a-c table and coiler motors on steel strip mills, whereas there are now a dozen or more d-c installations. We have alone supplied mill type table and coiler motors for eleven hot strip mills, including three replacements of a-c drives, and we are now building equipment for three more mills. These fourteen equipments include about 2300 motors totaling over 11,700 hp.

In confirmation of Mr. Tull's observations on maintenance costs, the following information on two other installations of mill type d-c table and coiler motors may be of interest. One of these went into service in 1939 and in 1946, after handling about three million tons of steel, it is reported that the equipment had never lost a motor armature and that only three or four bearings had been replaced. In fact, of the six spare motors available at this installation, four had never been unboxed.

The other installation was put into service late in 1938, and detailed records for the first 37 months of operation are available. These show the following:

Runout table motors—

18 motors changed:

6—for general overhaul (periodic in this plant).

2—to try out a new type of coupling.

1—to straighten shaft on motor dropped by mechanics.

1—because of bad threads on shaft extension.

1—due to open shunt field.

2—due to loose grease deflector plates.

5—due to bad bearings.

Brushes showed ¼ in. wear, or about 20 per cent of the usable amount in 1247 days of operation.

Cooling bed and coiler tables—

7 motors changed:

6—armatures roasted out due to binding or stalling of rolls. (Thermal relays have since been added to protect against stalling).

1—general overhaul.

Brushes showed ⅛ in. wear, or approximately 10 per cent of the usable amount in 1247 days of operation.

Coiler motors—

16 motors changed:

7—for general overhaul.

1—for bad keyway.

1—due to over-greasing.

3—for bad bearings.

1—due to loose grease deflector plate.

1—due to grounded shunt field.

1—fields grease and water soaked.

1—due to grease in motor.

Brushes showed ¾ in. wear, or approximately 60 per cent of the usable amount in 1247 days of operation.

In his paper, Mr. Tull shows a price advantage of 30 per cent in favor of d-c drives over a-c, the figures being made up of a 14 per cent saving in equipment cost and 16 per cent in cost of installation. The price picture has changed somewhat since 1937, and we can no longer expect any appreciable saving in equipment cost by the selection of d-c drives. However, the savings in installation cost, power consumption, and maintenance still apply. But even if there were no cost savings whatever, the mill type d-c drives are justified on the tables and coilers of the larger and faster strip mills on the grounds of superior performance alone.

Mr. Tull has given the manufacturers something to think about in reporting the troubles experienced with the d-c table and coiler drives. On later installations damage to the protective devices has been avoided by grouping them into floor-mounted cabinets located some distance away from the tables. The manufacturers are also striving to increase the degree of protection against water. It is believed, however, that protection against the troubles caused by warping of the rolls can best be obtained by spindle drives such as those mentioned by Mr. Tull. These have the additional advantage of getting the motors further away from the tables, providing more protection from the heat of the strip and from the water spray.

As Mr. Tull points out, there are still many sound applications of a-c runout table motors. These are on tables which normally run continuously and also on some of the smaller, slower, and lighter tables which operate on duty cycles of frequent starting and stopping. It is likely, however, that a-c drives cannot be justified on steel strip mills where the width is of the

order of 40 in. or more, and where the delivery speed is of the order of 2000 fpm.

L. A. Umansky: Mr. Tull's presentation, giving complete operating records of d-c drives, is of great interest to all of us, and particularly to those who, like myself, had originally participated with Mr. Tull in this venture. It would be natural for us to be a little boastful of the fact that the original suggestion of some 12 years ago is now being universally followed in the strip mill practice.

However, instead of boasting of our accomplishments, I suggest that we strike the note of humility. After all, the drive which we discussed today is nothing but an adjustable voltage system suggested by Ward-Leonard some fifty years ago. To be sure, we have added to it some refinements such as rotating regulator control and the like, but the substance of the arrangement is the same.

Just the other day I ran into several original papers presented by Mr. Ward Leonard before the turn of the century and describing his system so new then and so well known now. The reading of these papers depressed me very much, not because they were poorly written, but for the diametrically opposite reason. Mr. Ward Leonard presented the merits of his system so lucidly and well, that we, after using his method for some 50 years, could not do a much better job of presenting it now. Our 50-year progress in this line has been quantitative rather than qualitative; dealing more with refinements than with new principles.

And this brings me to the next point. In September 1937, when I presented before this Association a paper describing the d-c drives for tables and coilers, I expressed the hope that the new system then presented will not remain "new" for very long; that someone will introduce something better, and this, in turn, will challenge us to think of something still better and still more efficient. This challenge is worth repeating eleven years later.

J. Raymond Erbe: Mr. Tull is to be congratulated on the thoroughness with which the initial investigation regarding the merits of a-c variable frequency drives for this application versus d-c adjustable voltage drive was conducted. It is quite evident that the economics were very thoroughly scrutinized before making the ultimate decision to install the d-c adjustable voltage drive.

It was also interesting to note that the actual drive has turned out to be more efficient than the original investigation indicated.

The maintenance data given by Mr. Tull is also of considerable interest, since, as he has pointed out in his paper, one of the prime considerations in making such an application revolves around the question of the maintenance of brushes and armatures of the d-c motors versus the squirrel cage induction motor having no armature, commutator, or brushes.

We would like to take this opportunity to add that in a recent hot strip mill installation, one additional step was added. In addition to making the runout tables and coilers adjustable voltage d-c, they have been speed matched with rotating regulators with the final finishing stand of the mill. With this arrangement, once the coiler operator has adjusted the speed of the runout table sections and the coiler with that of the mill, any changes in the speed of the mill made by the mill operators does not affect the operation of the tables and coilers since they follow automatically and always maintain the same relationship with the strip speed. As the coiler operator is usually one of the busiest operators in a hot strip mill, this has materially aided in relieving him of most of the table and coiler manipulation, thus leaving him free to give more attention to the other controls under his direction. Furthermore, once the relationship between the mill and the tables and coilers has been established to provide the most satisfactory operation, it is believed that better coils and fewer cobbles will result which will increase the yield of the mill.

R. A. Geuder: The author mentioned one consideration that caused his plant to remove the motors from one side of the table and install them on the other, and to introduce a flexible spindle between the roll and the motor.

I would like to suggest for your consideration another solution to Mr. Tull's problem. The floating motor, Figures 10 and 11 successfully installed in a number of

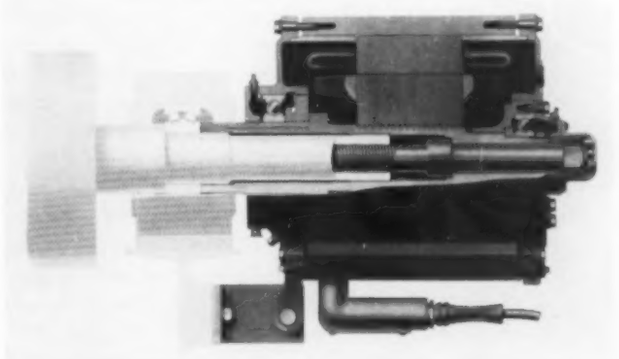
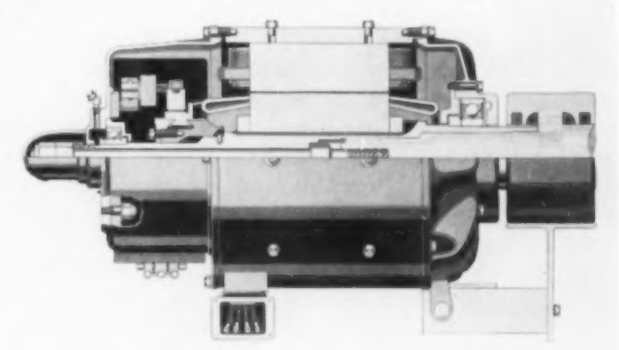


Figure 10 — Sectional view of a-c floating motor

Figure 11 — Sectional view of d-c floating motor.



mills, uses a combination of mechanical and electrical principles quite effectively. I think you may find it will go a long way towards part of the goal that has been set.

With this floating motor, we have made real progress on one of the troublesome maintenance subjects, that of the maintenance of alinement of the motor and roller. The floating motor has eliminated this problem. There are in service or being installed about 3000 of these units. So far the results have been very good.

Both d-c and a-c floating motors have been installed and to date bearing troubles, alinement and misalinement have not been problems at all.

CONTROLLING AND MEASURING STEEL TEMPERATURES

in Billet Heating Furnaces

. . . . the use of steel temperatures to control heating furnaces gives more accuracy, efficiency, and economy in heating the billet . . . .

By FRED S. BLOOM
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Pittsburgh, Pa.

▲ THE control of the heating rate of continuous pusher type heating furnaces is not an easy process. The rate of heating varies over wide limits from an instantaneous peak demand to a standby delay. To expect a heater to control a furnace, and in many cases, three or four furnaces consistently to an even product temperature is demanding more than a human machine can produce. Operating records of steel temperature indicate that with manual control, the steel temperature, half way through a continuous furnace very often varies as much as 300 F from a too hot condition to a too cold condition.

The writer, in this paper, wishes to discuss the measurement of steel temperature and to show various methods of controlling continuous billet heating furnaces from steel temperature measurements. The writer's interest in this subject started with an application in 1942, and from the original installation there were indications that it was possible to get a steel temperature reading from which furnace operation could be controlled within the limits of commercial accuracies demanded of the process.

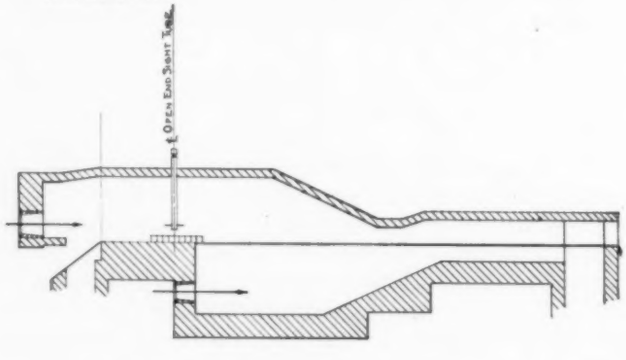
The first installation was made on a furnace shown in Figure 1. This is a two-zone, over-and-under-fired billet heating furnace. The under-fired burners were manually controlled from the panel board while the top-fired burners were controlled from the open-end radiation tube through which the sighting eye measured steel temperature. The open-end tube extended through the roof, and the lower end of the tube was protected by a large ring. The purpose of the ring was to prevent flame and wall radiation from affecting steel temperature measurement. The end of the tube was 14 in. off the steel surface, and air was blown through the tube to keep it clear. In this installation, an error was obtained due to flame passing between the end of the tube and the steel surface. However, by controlling furnace pressure and fuel-air ratio to give a constant flame density between the end of the tube and the steel, a fixed error could be maintained. This gave workable control so that the instrument could be set at a fixed temperature and all the billets from the furnace would be controlled to that temperature.

It was found that, without changing the temperature setting on the control instrument, the furnace would go through an extended mill delay without over-heating the steel. The first such experience was a two-hour mill delay, during which no resetting of the temperature recorder was made. The mill started up after this delay and steel at proper temperature was delivered for rolling. The rolling operation continued, and other than the adjustment of the fuel to the bottom set of burners, no adjustment of the furnace was made.

This installation indicated that there were possibilities in steel temperature measurement. The original installation of the tube through the roof lasted for approximately six months. The discouraging part about this installation was that when the open-end tube cracked and broke, it was necessary to wait for a long furnace shut-down in order to replace the tube, due to the method of installation. This difficulty of tube maintenance, plus the error due to flame interference, led to a desire for an easier method of radiation tube installation.

The second unit installed in 1944, is shown on Figure 2. This is a continuous pusher-type billet-heating furnace, heating 3½ and 4 in. square billets approximately 30 in. long, pushed in two rows. The furnace design and method of firing was such as to produce a horseshoe-type flame, and the point of steel discharge is at the first door in the high temperature zone. The other section of the furnace, or third-door section, was used for billet ton reheats. In this process, the billets

Figure 1 — A bar mill furnace 46 ft-10½ in. x 10 ft-0 in. was used for the first steel temperature measuring installation.



Presented before AISE Annual Convention, Cleveland Ohio, September 29, 1948

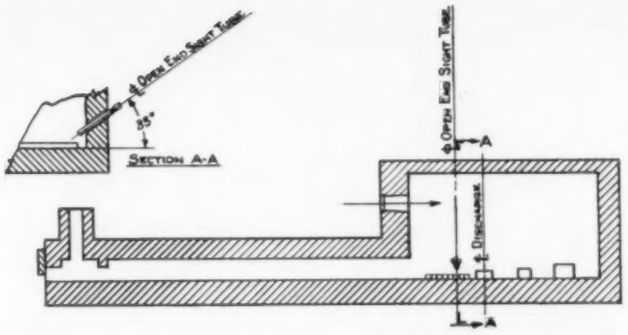


Figure 2 — In the second installation, an open end sight tube was installed at an angle of 35 degrees to the horizontal in a 32 ft-10½ in. x 5 ft-2 in. forge furnace.

are taken to a tong-forming press and a short end put on the billets for a tong hold. The billet is then returned to the furnace for a period of about four minutes, and given a wash-heat. This particular furnace design was made to accomplish the purpose of heating steel for forging and also to give a very hot chamber for a wash heat.

The height of the roof was such that it was not possible to install a vertical tube. Therefore an open-end sighting tube through the side wall of the furnace was tried. The point of measurement of steel temperature is shown in the figure. This gave a good record of steel surface temperature.

Figure 3 is a section of the temperature control chart which shows the change in steel surface temperature. Note that each time a series of billets are pushed, the temperature falls and then gradually heats up to its final temperature. The heating rate at this point is approximately 10 F per minute which is very fast for this location in the furnace. This fast heating rate was not expected. Previously this furnace had operated from furnace temperature measurement, and the difficulty that was encountered was that the billets were heated to a relatively high temperature, approximately 2400 F and that considerable furnace maintenance and washing of steel occurred because our furnace temperature was in the neighborhood of 2600 F, particularly so because of the desire to get a quick wash-heat.

Figure 4 shows the record of fuel flow. This record is a direct reading differential pressure from a gas orifice plate. It therefore changes more rapidly than the actual flow. A careful analysis of this chart indicates that the flow change, when billets are being controlled to temperature, is approximately 25 per cent of the maximum flow. This, of course, is a wide variation in flow and is not too satisfactory from the standpoint of furnace operation. This brings up a point which should be brought out at this time, and that is the need for instruments designed to control temperatures from steel temperature measurement.

The plant, in which this installation was made, felt that the rapid change in steel temperature was not a true picture of the heating cycle of the furnace. In order to prove whether this temperature change was true or false, it was decided to measure the center steel temperature by pushing a thermocouple imbedded in one billet through the furnace and to record the temperature. This temperature measurement was recorded on a fast recorder and the thermocouple was not removed from the billet until the entire operation was finished.

Figure 5 shows the temperature rise of the center of the 4 in. billet as it was pushed through the furnace. This curve indicates center steel temperature as related to position of the billet in the furnace. In this test we had very few delays, and no major delays.

Your attention is called to the steep slope of the curve at the final heating section. The arrow indicates the location of the open-end sighting tube which gives the record from which the furnace is controlled. If a comparison is made between the movement of 8 in. of steel for a horizontal push to the record obtained for the dropping off in temperature, as shown on the temperature control record, it compares very favorably. Each

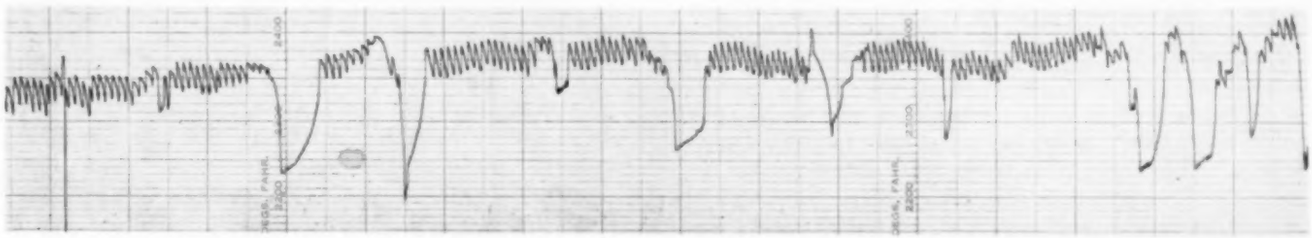
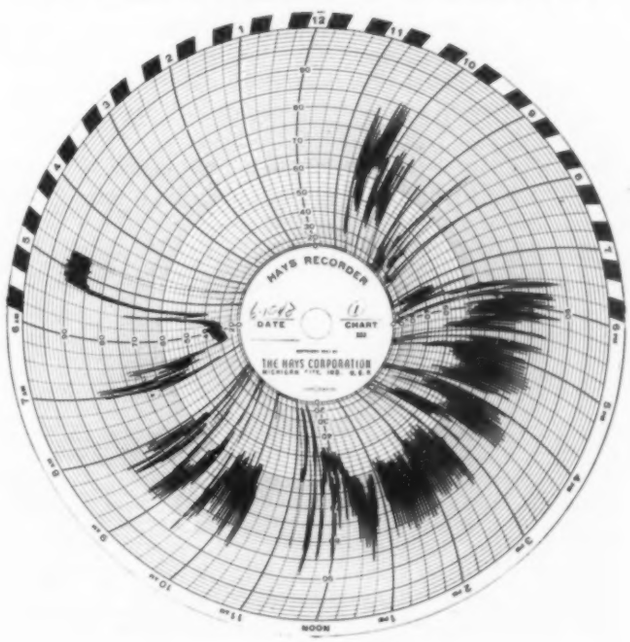


Figure 3 — The swings in the temperature of the billets for the furnace of Figure 2 are shown in this graphic recording chart.

Figure 4 — The chart shows the fuel input record which accompanied the billet heating shown in Figure 3.



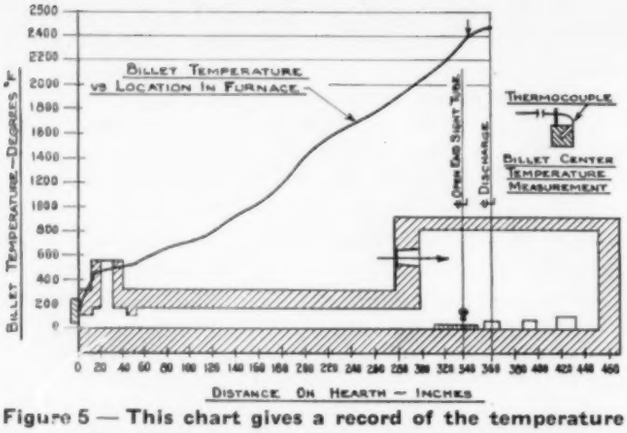


Figure 5 — This chart gives a record of the temperature at the center of a 4 in. billet, recorded by a thermocouple as the billet passed through a 32 ft-10½ in. x 5 ft-2 in. forge furnace.

8 in. of horizontal movement approximates the falling off in temperature that is indicated by the temperature rise of the test curve.

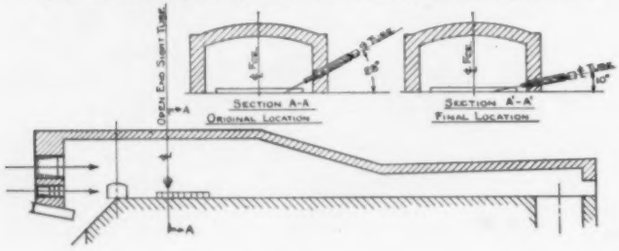
Please note that center steel temperature actually came up very close to surface temperature. In some of these tests, center temperature was actually higher than surface temperature. The cause of this may be inaccuracy in the setting of the sighting eye, although it was checked with an optical pyrometer of the hand-operated type.

The control by steel temperature measurement on this job was successful and it has continued to operate for five years. The steel temperature record is very stable. Steel temperature cannot change quickly unless the product is moving on the hearth. The flame interference was negligible on this installation.

Figure 6 shows another type of installation on an end discharge pusher-type billet heating furnace. In this installation the burner application provides two effects. The lower small set of burners which have a flame about six feet long, are used to heat up the discharge nose to relieve the usual cold spot. The second set of burners, which are controlled from steel temperature, fire high above the steel, and the flame from this set of burners does not come down on the hearth for a distance of approximately 9 to 10 ft. Therefore a pocket is provided between the flame from the lower burners and the flame from the top burners, which gives us a very good point of temperature measurement without flame interference between the eye and the steel.

The original installation of the open-end sighting tube was a copy of that shown in Figure 2 in which the sighting eye went through the side wall of the furnace at an approximately 28 degree angle. This arrangement

Figure 6 — In this 36 ft-6 in. x 8 ft-3 in. continuous heating furnace, it was found advisable to shift the location of the sighting tube to reduce hunting action.



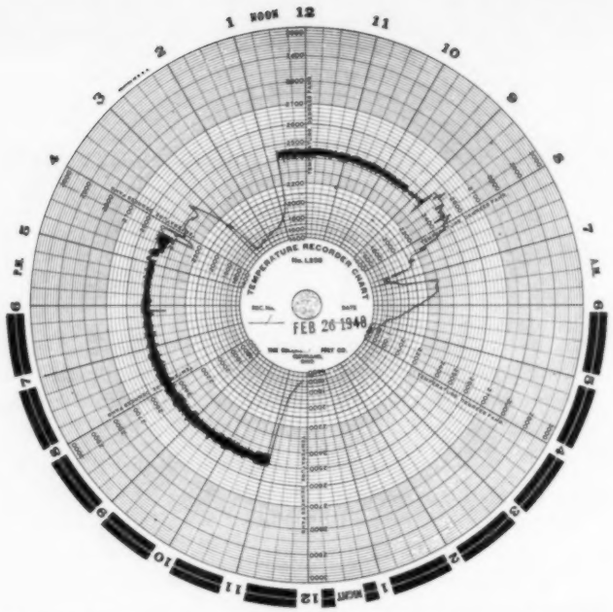


Figure 7 — Temperature record of billet heating furnace shown in Figure 6 when original location of sighting tube was used.

caused some difficulty, even though we could not see any flame between the eye and the steel.

Figure 7 shows the temperature record that was obtained with this original installation. Please note the slight hunting action indicated on this chart. This hunting action is entirely that caused by error in steel temperature measurement which causes the fuel flow to change too rapidly for good furnace operation.

The eye location was changed to that shown on the upper right corner of Figure 6. The angle of the sighting eye was made more horizontal to the steel surface, and a sight was made on the end and top corner of the billet. Figure 8 is a picture of this installation. Figure 9 is a record of temperature measurement after the eye was changed. Note that the temperature measurement

Figure 8 — Final location of sighting tube sketched in Figure 6 is shown in this photograph.

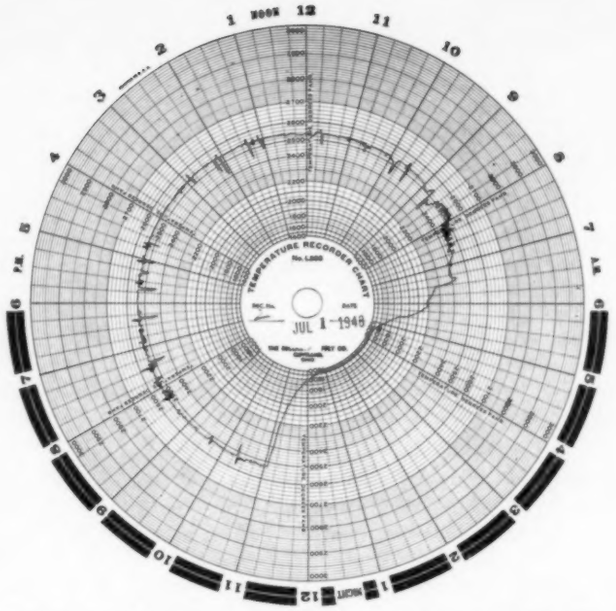


Figure 9 — Compare this temperature chart with that of Figure 7. The elimination of the hunting action through the better location of the sighting tube illustrates dramatically the effect of proper location.

record is now very stable. A temperature change occurs due to long and short billets. A change also occurs which is caused by a long billet extending out beyond the natural column of steel. This change is to be expected because the end of the billet is actually over-heated. In this arrangement there is an error, due to short billets, when the sighting eye hits the furnace hearth. This inaccuracy in not hitting steel billets causes an increase in fuel flow, but the duration is very short, and as long as billets are being pushed it gives no difficulty. If a short billet is in the eye location during a mill delay, the duration of high fuel flow is slightly longer, but not of sufficient length to cause any difficulty in furnace operation.

Figure 10 shows another temperature record for the same furnace. Note the very stable and distinct temperature record.

Figure 11 shows the arrangement of three furnaces under control in this line. One of the problems of heating steel for rolling is to keep all steel delivered from the furnaces at the same temperature. In this installation, there is a recording watt-hour meter on one finishing pass motor drive. This is very advantageous in picking out any billet which is colder than the rest. With steel temperature measurement, all three furnaces can be kept at the correct temperature, so that the power used on the finishing pass is uniform for every billet.

Figure 12 shows a record of the power consumption on the finishing pass. The power record on the left hand side of this chart indicates the power which was required, using furnace temperature as a measurement for control. To the right hand side of this chart we show the power consumption and variation for the same furnaces when steel temperature was used as a measurement for control. The chart on the right shows the more uniform power consumption, although since a different section was rolled, more total power was required.

Figure 13 shows an installation of an open-end sighting eye on a continuous roll-down seamless mill

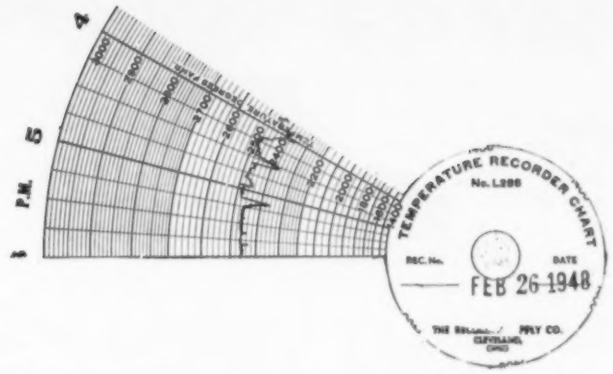


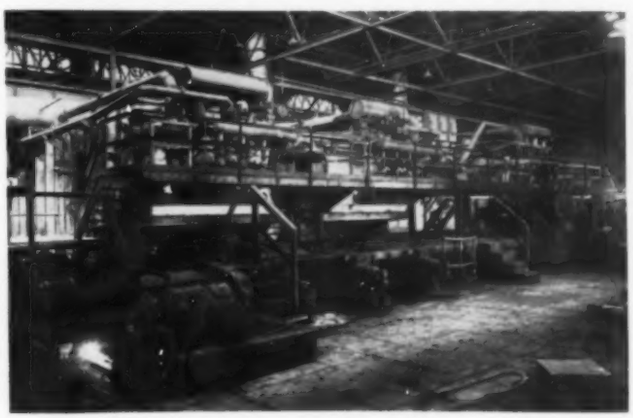
Figure 10 — Another temperature record for the same furnace covered by the chart of Figure 9.

billet heating furnace. This furnace has two zones of burners, top-fired. Both zones are heating zones. This job was tried with steel temperature measurement, knowing that the sighting eye would hit the furnace hearth at certain times due to the fact that the steel is rolled on the hearth and is not continuously in contact with each piece, one against the other. It was thought that the process was worth trying, in view of previous success. The installation was therefore made with a vertical open-end tube. It was thought that this would be preferable and the roof height was not sufficient to cause any difficulty with the vertical tube. Likewise the furnace is normally out of operation for at least four turns per week, so that a replacement of the tube can be made.

Figure 14 shows the temperature record which was obtained from this installation. This record is stable. The drop in temperature is caused by a batch of billets rolled at one time under the eye. Sighting on the hearth caused no difficulty because it was uncovered quite frequently and was always up near to the steel temperature.

Figure 15 shows the control arrangement used on this job. In this installation, the fuel input control to the second zone is controlled in relation to the fuel input to the first zone through a ratio regulator. It was thought that one point of temperature measurement was sufficient to control the entire furnace. The fuel input control is set up so that no fuel is burned on the second

Figure 11 — Three furnaces are under control in this line. Steel from each is to be delivered at the same temperature.



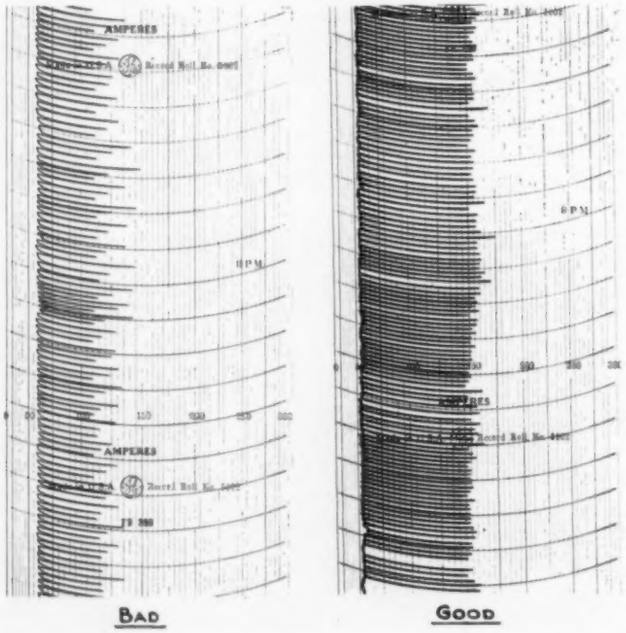
back zone until at least 40 per cent of burner capacity is being used on the front zone. As fuel is increased by temperature control on the front zone, so that when the front zone is firing 80 per cent of burner capacity, the back zone is firing 100 per cent of burner capacity. This arrangement has been satisfactory and allows more time to be spent in maintaining correct steel temperature measurement on the one eye to assure good accuracy, and relieves the operators of trying to maintain two temperature measurements.

This job has operated for nine months with steel temperature measurement and appears to be satisfactory for this type of control. The heaters and mill operators are thoroughly satisfied with the results of the furnace operation.

The fuel economy of such a system of furnace control is improved because additional fuel is added in the back zone only to compensate for the additional tonnage demanded. The waste gas temperature leaving the furnace is therefore kept to a minimum.

The measurement of steel temperature in a triple-fired furnace is approximately the same as that of measuring steel temperature in the smaller single-zone or two-zone top and bottom fired furnaces. The control from steel temperature measurement in the triple-fired furnace is more difficult. You can realize this when you appreciate that in the long triple-fired furnace, some of which are 80 and 90 ft long that the control of the main heating zone burners must be from a point of steel temperature measurement which is on that part of the curve that is rising in temperature rapidly. Likewise in the triple-fired furnace, many of these applications will be to measure the temperature of a wide slab which may be 5 ft or more. This 5 ft represents one-twentieth of the length of the furnace. The heating rate is therefore on a basis of increasing from room temperature to maximum steel temperature of 2300 F in twenty pushes. Thus each push, on the average, is approximately 100 F or better. In the main heating zone it can be

Figure 12 — Power consumption on the finishing pass is much more uniform when steel temperature is used to control the heating furnace.



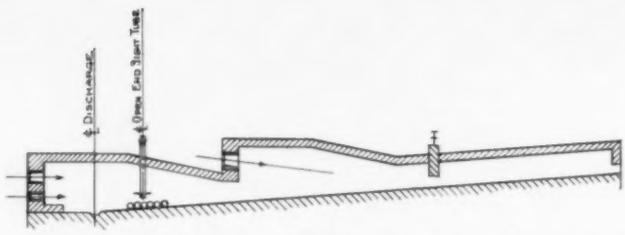


Figure 13 — The open end sight tube has also been used to measure billet temperatures on a 55 ft-0 in. x 12 ft-0 in. piercing mill furnace.

expected that the difference between two slabs, one in back of the other, can be as much as 120 F. Thus, when the slab in back replaces the previous slab, the steel temperature must drop approximately 80 to 150 F depending upon the location of the sighting tube. In the final heating zone of such a furnace, steel temperature should be quite stable. However, we push in many triple-fired furnaces, 6 in. slabs in back of 5 in. slabs, and slab thickness plays an important part in slab temperature, particularly since all slabs, if following one in back of the other, go through the same temperature cycle. Therefore, on the hearth of a furnace where slab thickness varies it should not be expected that straight line temperature record will be obtained.

Figure 16 shows the application of two open-end sighting tubes of the 5 degree angle type, sighting on the end of steel slabs in a triple-fired furnace. The eye in the main heating zone controls the fuel input to both top and bottom burners. The eye in the final zone controls the fuel input to the top burners only. The small burners at hearth level, fire at a constant rate to maintain nose temperature.

Figure 17 is a record of the final zone steel temperature. This temperature record is very stable. It is quite different from that which we had been led to expect from visual observations of such a furnace. However, this furnace heats wide slabs and slabs of different thicknesses for a large plate mill. The slabs vary in length and vary in thickness. It is not unusual to have a 7 in. slab in back of a 6 in. slab. Therefore, from the standpoint of accuracy of temperature measurement, this record appears to be within the realm of practical application.

A careful analysis of this chart will indicate the temperature rise is approximately 3 to 4 F per minute, for steel laying on the hearth of the furnace. This chart in some instances indicates thin slabs and thicker slabs. When the slab is pushed out, the temperature actually goes up, which shows that the slab ahead was thicker than the slab that came under the eye. In other cases, there is a large drop in temperature, as much as 100 F showing that the slab that was then pushed under the eye was thicker than the one previously under the eye, all of which indicates that, even though the chart is quite ragged, the information given by the record is true. When uniform thickness of slabs are pushed, such as that part of the chart from 12 midnight to 9:00 am, a very respectable chart is obtained and all steel that is delivered to the mill is at a temperature within plus or minus 5 F.

Figure 18 shows the temperature record of the slabs measured at a point approximately 55 to 60 per cent of the way through the furnace. The temperature is

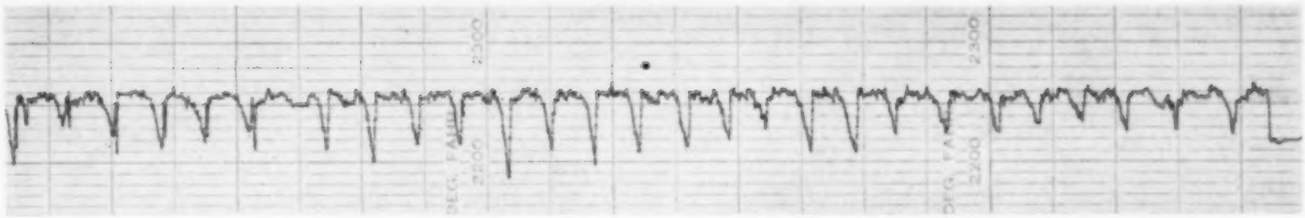


Figure 14 — A stable temperature record is indicated by this chart for the furnace sketched in Figure 13.

measured on the end of the slab. The readings fall between temperatures of 2100 and 2200 F. This record indicates much better than does Figure 17, the effect of thin and thick slabs. Please note at a time of 9:45 pm where a slab is pushed and the temperature jumps 100 F. Then, at this time, it is above the control point, and when this slab is pushed out from under the eye, it drops again the 100 F which indicates that there had been a thin slab in between two thick slabs.

The trueness of temperature measurement is a point for discussion. You know that steel temperature in a furnace of this type cannot increase or decrease rapidly. If the chart is analyzed from this standpoint, it must be agreed that the temperature record is fairly accurate. The width of the record line indicates that there is very little, if any, error due to flame radiation.

The record as shown on Figure 18 is used to control the fuel input to the top and bottom zone burners. The ability to control fuel input where temperatures vary for each movement of steel, such as will occur in the main heating zone of a triple-fired furnace creates a demand for a temperature controller which may not exist today. At least the instrument should be adjusted to minimize the valve motion for temperature changes of 100 F because it is not favorable for a furnace to change in fuel input continuously for every movement of steel. The instrument in design and selection should be such that the fuel input to the main heating zone should remain fairly constant, unless the deficiency or the excess in temperature is maintained for a considerable period of time.

This means that the control instrument must have a very wide throttling range and a fast droop corrector.

Figure 15 — Arrangement of oil piping for furnace sketched in Figure 13.

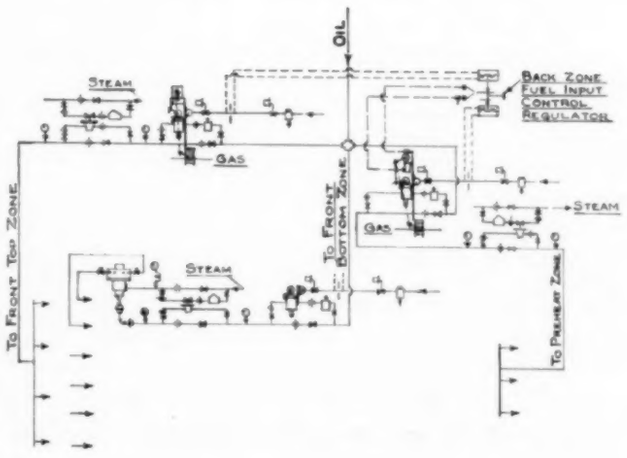
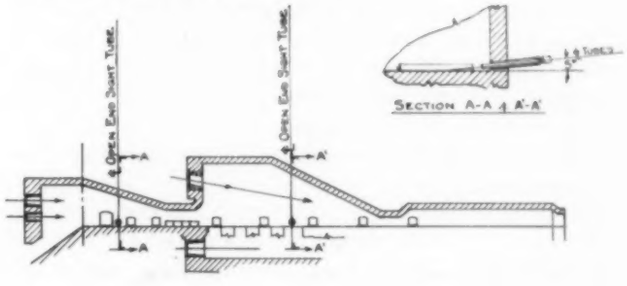


Figure 19 is a reproduction of a temperature curve shown to the AISE by J. W. Percy, "Measurement of Heating Rates in Reheating Furnaces," Yearly Proceedings Association of Iron and Steel Engineers, 1947, P 401, which indicates surface temperature as determined by him in tests on a similar type continuous billet-heating furnace to that shown above. On this curve, the location of the sighting eye on the triple-fired furnace where temperatures were measured and given in Figures 17 and 18 is indicated by the arrow. To this curve is also plotted a dotted line which is shown to express a condition which normally exists in the operation of a triple-fired furnace and which causes more difficulty than anything else in the operation of the triple-fired furnace. This is a point which should be studied and eliminated before complete automatic operation of the triple-fired furnace is accomplished.

It has been the practice in most plants, operating continuous billet-heating furnaces, to continue to heat steel in the furnace after the mill shuts down for a delay. A continuous furnace is a furnace which operates very satisfactorily, providing each section of the furnace does its respective job. However, many times the furnace is thrown out of balance by such practices as heating steel during mill delays and quite often it takes an hour, or an hour and a half before the furnace gets back on an even heating cycle. To explain this, note the dotted line which indicates steel surface temperature at the end of one hour of mill delay. The steel in the back of the furnace is allowed to increase in temperature. In most cases, this is intentionally done so that the heater has a reserve of well heated steel for a short period after the mill starts up.

Let us observe what happens after the mill delay is over. Immediately, the steel is pushed and steel enters the furnace at room temperature, pushing a billet ahead of it at a temperature of approximately 1000 F. As this pushing operation continues, the cold steel lying directly behind the 1000 F heated steel causes a very

Figure 16 — Two open end sight tubes were installed to control temperatures in a 62 ft-5½ in. x 13 ft-9 in. continuous plate mill furnace.



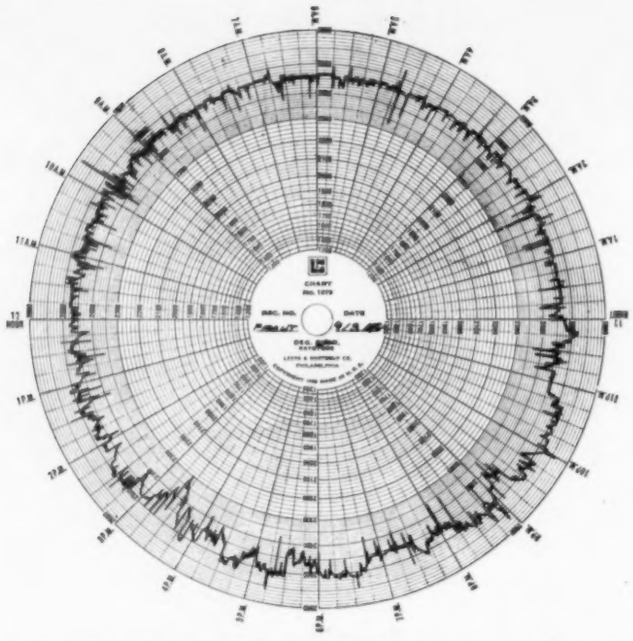


Figure 17 — Slabs of different thicknesses going through the furnace have an effect as is shown on the temperature chart.

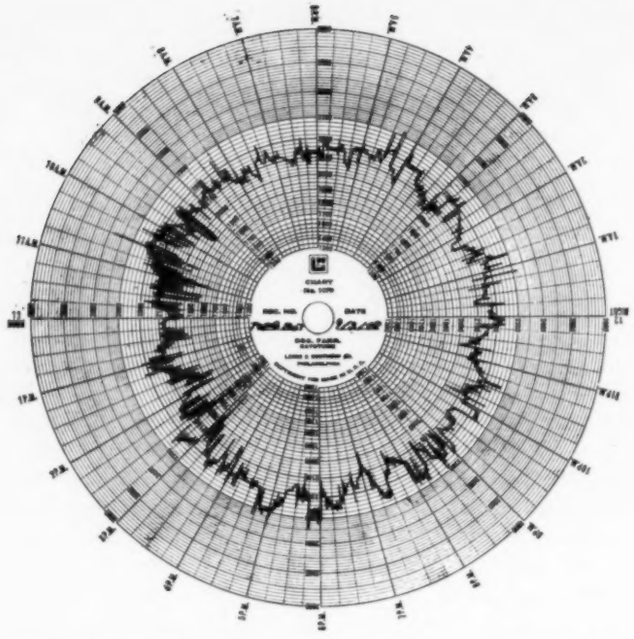


Figure 18 — This chart illustrates most effectively the effect of thick and thin slabs.

serious furnace upset. In many cases, the furnace will deliver steel for thirty minutes before it is possible for the heater to turn on much fuel to the main heating zone burners. If the heater turns on fuel to the main heating zone burners with hot steel way back in the furnace, this steel must be overheated. If he does not turn on the fuel, the cold steel that has been pushed into the furnace, after the delay is over, does not become heated. In any case, the steel in the furnace at the junction point between the cold and the well preheated steel causes a very serious drop in temperature when this steel passes under the steel temperature measuring eye. This condition has been observed in many plants where open-end sighting tubes have been used for steel temperature measurement and control.

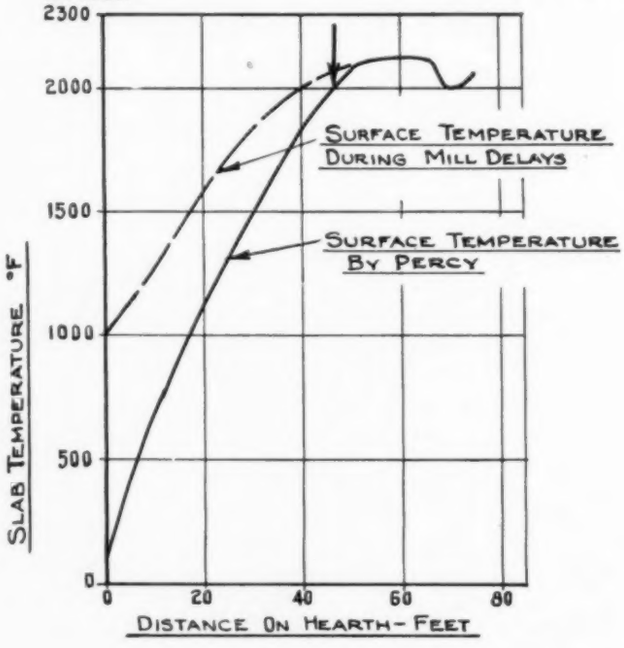
To correct the above condition it is only logical to attempt, so far as possible, to prevent the steel at the charging point in the furnace from becoming overheated during periods of mill delay. It is recommended that during mill delays the temperature setting on the control instrument be immediately reduced to prevent this overheating. It is quite possible to drop the steel temperature in the furnace as much as 200 F so that full fuel flow can be put on the main heating zone burners as soon as the furnace starts to push steel to the mill.

Experience indicates that 90 per cent of the furnace maintenance troubles occur during periods of mill delay when an excess of fuel is used to a detriment of the furnace operation. All furnace operation should be designed to keep the heat pattern as close as possible within very close limits. Any change from the standard heat pattern of the furnace will cause difficulty in either maintenance or furnace operation.

The experience described above indicates the following conclusions:

1. The continuous billet-heating furnace can be controlled by a steel temperature measuring controller.
2. Steel temperature measurement and control can eliminate at least 75 per cent of the vigilance required of an experienced heater.
3. Steel temperature measurement and control can eliminate at least 75 per cent of the slag conditions and scale buildup on the hearth of the conventional furnace.
4. Experience indicates that steel temperature measurement can increase furnace production at least 10 per cent without additional changes.
5. Steel temperature measurement has indicated the value which has always been assumed to be correct in the use of air/fuel ratio and proper furnace

Figure 19 — Surface temperature of 7⅛ in. x 30 in. x 211 in. slab as it passes through a continuous billet heating furnace.



pressure. It is possible to demonstrate the fuel saving which can be attributed to these two automatic machines.

The steel temperature reading will quickly indicate any change in furnace pressure or in fuel/air ratio. It is easy to set these controls at their proper value by watching the temperature record and thus obtain maximum furnace efficiency.

DISCUSSION

PRESENTED BY

E. C. HITE, Maintenance Engineer, Timken Roller Bearing Co., Canton, Ohio

F. McGOUGH, Fuel, Engineer, Republic Steel Corp., Youngstown, Ohio

W. W. TRINKS, Associated Engineers, Pittsburgh, Pa.

F. S. BLOOM, Bloom Engineering Co., Pittsburgh, Pa.

JOHN R. GREEN, Manager Steel and Ceramic Division, Brown Instrument Co., Pittsburgh, Pa.

EDWARD G. BUSCHOW, District Manager, Surface Combustion Corp., Pittsburgh, Pa.

J. MAJOR, Assistant Combustion Engineer, Youngstown Sheet and Tube Co., Campbell Works, Youngstown, Ohio

E. T. MORTSON, Superintendent Fuel and Power Department, National Tube Co., McKeesport, Pa.

JOHN A. DUFAULT, Sales Engineer, Leeds and Northrup Co., Cleveland, Ohio

E. C. Hite: Recently, there has been much discussion as to the reliability and advantages of furnace control when operated from steel temperature measurement rather than furnace temperature. Certainly the statements that one installation has been working satisfactorily for four years and also that in one case production has been increased from 35 to 50 tons an hour would indicate some real incentives for us to do further work on this method of control.

F. C. McGough: Were these radiation heads compensated for ambient temperature changes?

Member: I would not worry about ambient temperature at all. They are water-cooled. Of course there are many cases where you do not even have to bother about water-cooling.

F. C. McGough: I can see that is possible, if you are interested in anything less than 50 degrees, but I think Mr. Bloom talked of 15, 20 or 25 degrees.

We have had actual experience that has indicated that ambient temperature compensation is not only desirable but absolutely necessary.

There are many factors to be taken into consideration. One is the amount of purging air. The temperature can vary very quickly due to small changes in pressure of the purging air. You have conditions on an open tube installation that are affected by ambient temperature changes, where transient and possible sustained error result, that you do not have in a closed tube installation.

The installation referred to by Mr. Bloom may be perfectly satisfactory for low carbon steel. However, where you are trying to control a high grade carbon steel or alloy to very close temperatures, it would not be satisfactory without these factors being taken into account.

W. W. Trinks: Mr. Bloom showed in Figure 1 that he had a tube which came down within 14 in. of the steel, and he showed that that flame falsified the result to a certain extent, but that the falsification could be taken into account just the same as if my watch is ten minutes fast. If I know that, then I still know what the right time is. In the same way he could measure the temperature of the steel as it came out of the furnace and compare it with the reading of this instrument, thus calibrating it.

Later on he used a tube which was sighted on the top of this steel, and he spoke of glare. Now what is that glare? That glare is reflection of the roof from the almost molten scale. Unfortunately, we cannot heat steel without scale, at least not for this purpose, and we certainly get the wrong temperature by that method.

I refer to a test made by a certain Mr. Wesemann, which was reported in "Stahl & Eisen." He had three thermocouples in a heavy billet, one as near the top as he dared go, one in the center, and one at the bottom, and he also sighted against the top in the same way in which Mr. Bloom did, and he found that the top of the scale was 600 F hotter than the top of the steel. Of course, he was mistaken, because what he measured was a reflection from the roof.

As a matter of fact, his scale measurements were within 50 degrees of the roof temperature, and that of course is utterly impossible. It shows the effect of glare that Mr. Bloom spoke about.

So Mr. Bloom did the right thing in abandoning that method.

Now we come to the idea of putting the instrument on the side, which is a very good thing. We still have a little scale there, which also falsifies the result. I think Mr. Bloom spoke of 2480 F when the steel is only to be heated to 2200 F. However, again we can consider it in the same manner as the watch that is 10 minutes fast. If the operation is reasonably steady, then it is the right thing to do, to use that indication as the measurement and simply compare it to the temperature of the steel as it comes out.

It reminds me of what I found in Charleroi, Belgium. I went to a glass plant, and I saw there a pyrometer that sighted on the door in the glass furnace near the end, where the glass flows to the machines. I sent for the superintendent. I asked, "Now, what do you get here? This reading does not show you anything. It shows you the reading of the glass temperature, but glass is transparent. Therefore, it also shows you the temperature underneath the surface. You also get a reflection from the roof. So what do you get?"

He said in French, "What do we care? We know that if that pyrometer shows that particular point which is marked red, we get good glass, and if it departs either way for twenty degrees, we get poor glass. I do not care what temperature we get, but I know that is the way to get good glass." It is the same thing with steel.

The next thing is that heretofore it has been customary to use the roof temperature, that is to say, the temperature which exists near the pyrometer, which reaches through the roof just a short distance. Now again we can use the watch analogy — only in this case

the watch will not be ten minutes fast but it may be twenty or more minutes fast. In other words, the difference between roof temperature and steel temperature is great and heretofore we have said, we know if we have such-and-such a roof temperature we can get the correct steel temperature.

Perhaps Mr. Bloom has done something of that sort and can tell us to what extent his device is better than the one which we have been using heretofore.

Fred S. Bloom: The difference between operating a furnace from steel temperature measurement or furnace temperature measurement is accuracy. I have found steel temperature measurement to be closer to the true steel temperature than is furnace temperature measurement. We have operated many continuous furnaces with both arrangements. We have operated the same furnace with simultaneous records. Both systems of temperature measurement and control will work. Many continuous heating furnaces are working satisfactorily with control from furnace temperature. Almost all continuous heat treating furnaces use this method. I know of one ingenious engineer who is using an open end tube to control a heat treating furnace by measuring surface temperature. He has found that he can get increased capacity, with equal quality, from the heat treating unit.

The reason for all this work is to obtain more accurate control of our heating process. If we obtain more accurate control, we can improve production. The closed end tube for measuring furnace temperature gives a very uniform control record; while the open end tube measuring steel temperature will show quick variations for each movement of steel that passes the eye. It is possible to distinguish the different temperature which we could expect to exist between slabs of various thicknesses when one follows the other in passing under the steel temperature measuring element. We can also observe the heating rate by noting the rate of temperature rise for a given period as the slab lies in a fixed position on the hearth in front of the steel temperature measuring eye. The furnace temperature measuring element gives no record whatever of this condition.

Therefore, since we can get a measurement of what is taking place in the product being heated, we can better understand what steps are necessary to improve production and control the heating rate.

The control accuracy is an important tool. I mentioned in the paper experiences with three furnaces heating steel to a single mill. These furnaces had previously been operated by furnace temperature for many years. Then they were changed to steel temperature measurement for control. This change reduced furnace repairs, slag troubles, and increased furnace production by better than 20 per cent without any other changes.

Professor Trinks has brought up one item that cannot be overlooked, scale, and we have discussed this before. Professor Trinks quotes a Mr. Wiseman as showing scale temperature 600 degrees higher than steel surface temperature. This may be true even though Professor Trinks thinks it is impossible.

From our experience, I am almost willing to think that Mr. Wiseman is very close to the answer to many of our problems. It is quite possible that scale temperature is the reason why we consider soaking so important. It may be that the difference between scale temperature and steel temperature is what we decrease when we soak steel. Actually, what we are doing is dropping scale temperature down to steel temperature, and that equalization within the steel is not accomplished in soaking so much as is scale temperature being equalized to that of steel temperature. If this is the case, we can explain very logically the errors we see in steel temperature measurement. It is not glare which causes errors, it is the fact that scale temperature can be increased or decreased very quickly above or below steel temperature. It also explains why we have found that to get extremely good control results, it is necessary to measure steel surface temperature at a point in the heating operation which is very close to the point of steel discharge. We have always obtained good control of furnace operation when we properly measure surface temperature at this point. This can be explained very logically when we consider that the heating rate at the point of steel discharge is relatively slow, and consequently the scale temperature is relatively close to that of the steel temperature. It is my opinion that the difference between scale temperature and surface temperature is a function of the rate of heat input to the surface of the scale and into the steel. Thus scale temperatures in the high capacity heating zones can be extremely high above the actual surface steel temperature.

John R. Green: As Fred Bloom has properly said, the control of the reheating furnace is certainly not an easy job. I think we are all agreed that the ideal way to do it, if you can, is to control from a measurement of steel temperatures.

We are also equally agreed that measurements through the roof of the long sight tube introduces too many practical problems to be in the long run a suitable answer to the problem. The side wall location with open end sight tubes appears to be the solution.

As was pointed out in the illustrations, the lower and flatter the angle of those sighting tubes, the better are results secured.

How satisfactory that method can be is dependent largely upon the design of the burner, the location of the burner, and in many cases the fuel that is being used.

One additional point that we should bear in mind is that a parallel operation of two radiation heads from opposite sides of the furnace does a great deal to give a true average reading of this steel temperature.

I will not quite agree with the statement that as long as you can stay away from the glare you do not have any problem. We do have to keep in mind that radiation elements measure things that your eye cannot see. Do not forget that when you begin to apply radiation tubes to the side wall, there is also a trend, and a very logical trend, to control of all zones of multi-fired furnaces, two zones, three zones, by having individual control systems on each zone.

Another possible answer to the problem, where it is not possible or practical to take steel temperature measurements by radiation sighting tubes and we have to depend upon furnace temperature conditions in the combustion zones, is to take full advantage of temperature changes in the gas exit. These temperatures may be used as a means of automatically setting control points on the original heating zone and the soaking zone, which can be reestablished on a rationing basis, for the distribution of fuel.

Fred S. Bloom: Mr. John Green's remarks tend to complicate the problem by adding additional mysteries. Regardless of the difficulties or their nature, a workable measurement can be secured from which fuel input can be controlled. The present steel temperature measurement should not be considered a final solution. It is hoped that with additional installations and with a greater interest from the instrument manufacturers, many of these mysteries can be explained and eliminated. The thought I wish to get across to this audience is that we have been able to hold the finished temperature of a piece of steel being pushed through a continuous furnace, so that it is delivered to the mill at a temperature which can be duplicated. We do not attempt to say that the temperature read by the instrument is correct, but so long as the temperature is maintained at a fixed temperature, the steel going to the mill is at the same temperature for each piece, one after another.

E. Buschow: One question uppermost in my mind is: "Why did you not use a closed-end radiation tube with the target-end of the tube rather close to the steel, in order to eliminate the effect of flame interference?

Fred S. Bloom: Mr. Buschow suggests using a closed end tube located close to the steel surface for a more accurate measurement of steel temperature. We have tried this method. The closer the closed end tube is to the steel, the more it reacts to steel temperature. However, we have never found that this method compares at all favorably with the steel temperature measuring method. It has not been the answer because it measures the combination of two temperatures; furnace temperature and steel temperature. Likewise, on many jobs, we cannot get the closed end tube very close to the steel without breaking the tube. With the open end tube we get as close to steel as we dare, and then we jump the gap with the open end eye.

Jack Major: We have the closed end tube, and Mr. Bloom is right in the fact that the variation is not very great on mill delay. We get our own furnace changes rapidly. I did not expect to get in on this part, but I had one question I wanted to ask on that.

You talk about your small sighting area. Do you always get your slabs or billets directly in this small sighting area? You have a mill delay. Your furnace is pretty well up to temperature. You get the mill delay and what happens on this, you are sighting between two slabs, and get slag variation between two billets? You get pretty hot in that front zone before your control takes over.

Fred S. Bloom: The difficulties in controlling from steel temperature on mill delay are not too great. We have established a practice that all steel temperature controlling instruments must be reset during a mill delay. What we do is to reduce the control point setting by as much as 100 to 300 degrees, depending at what point in the furnace length the instrument is located. With this system, if the sighting eye does not hit a slab during a short interval of push, it does get back to a good point of measurement as soon as the next slab is pushed. However, if the mill delay occurs while a short slab is not being hit by the sighting eye, then the temperature is reduced by the furnace operator and no damage occurs.

It was our original thought that by measuring steel temperature, mill delays could be encountered without resetting the control temperature instrument. However, we soon found out that this practice was faulty, because, as we have explained in the paper, we ran into many other difficulties which had not previously been recognized. Thus I established a definite practice to reset the control point for all mill delays regardless of the duration. We are able to keep the furnace under reasonably accurate steel temperature control measurement. I have mentioned before that most of our difficulties are caused by improper operation of the furnace during mill delays.

We have also attacked the problem of not hitting a billet due to short billet lengths by the installation of the open end sighting tube in various arrangements. We have tried on some furnaces to install the tube horizontal with the hearth at an angle 30 - 45 degrees off the center line of billets. With this arrangement, if we miss a billet we hit the side of the adjacent billet.

E. T. Mortson: We have several roll-down seamless mill heating furnaces equipped with automatic temperature controls using closed end sighting tubes. These controls have been in operation 4 or 5 years and have proved more reliable than manual operation. We concur that the use of closed end sighting tubes for temperature measurement results in a relative temperature and not a true billet temperature. However, with operations normally at capacity, closed end sighting tubes will result in good furnace temperature control, much better than previously obtained by manual operation. Where operations are intermittent, an open end sighting tube would no doubt be required. Several heating tests have been conducted on these furnaces which indicate good heating conditions. We still believe, for our operations, a closed end sighting tube for temperature measurement in roll-down type furnaces is satisfactory.

John A. DuFault: After listening to Fred Bloom's paper and the various comments on the application of radiation tubes to slab heating and round billet heating furnaces, I would like to make a few comments.

Relative to the use of closed end versus the open end target tubes, our experience indicates that closed end tubes give a good answer on large furnaces where the rate of output is fairly constant. On that type of application we operate on a constant differential, and the steel is delivered to the mill at a desirable uniformity.

When the unexpected happens and the rolling mill has to stop quickly due to cobbles or other unexpected delays, the heating furnace has to be cut back quickly and needs quick manual attention. There is no automatic control that can guess what unexpectedly happens to the rolling mill, and if the automatic controls are depended on to cut back the furnace until the steel reflects an increase in temperature it will be too late.

On the subject of heating of steel, there are two schools of thought. One school wants increased tonnage out of undersized furnaces and indulge in race heating. The result is overheating in the entering or heating zone, and then they try to equalize the steel temperature in the soaking zone. The other school of thought believes that steel should be heated in accordance with a time temperature program so that when the steel is discharged its plasticity which is related to its critical points will be more closely controlled. This method is being reflected in new designs of furnaces, which are

much larger for a given tonnage and allow slower heating rates.

In connection with the use of the open target tube for direct sighting, our company has done a great deal of work over the years. The mirror effect or glare effect has been taken care of through the use of a radiation shield. Open end target tubes 70 and 105 inches in length are being used and the radiation shield is suspended just above the work. On high temperature furnaces the assembly is made of silicon carbide. If the installation is not handled carefully, maintenance is apt to be high.

If the open end target tubes are shortened, improper readings are obtained unless the atmosphere is clear. This type of installation cannot sight through heavy orange flame atmospheres. On this type of application the tubes are installed in the side walls as near the steel as possible and usually operate just above and below the steel or from the ends of the billets. On these applications, we have installations giving satisfactory results with both open and closed end tubes. If the atmosphere is clear from the open end of the target tube to the steel, a reading can be obtained that is more nearly the actual temperature of the steel with an open end tube as against a closed end tube.

I would like to answer one question raised relative to correction required for variation in ambient temperature on the radiation unit. If the radiation unit is properly installed on a heating furnace of the type under discussion, where the operation is continuous, the variation in ambient temperature has a negligible effect on the temperature control.

Fred S. Bloom: Mr. DuFault mentions one thought which should not be left unchallenged. He speaks of two schools of thought: one which deals with what he calls race heating and the other which he calls time-temperature program heating. The audience can interpret this remark to be an inference that race heating is wrong, and that we should do our heating by time-temperature program method. We must realize that today production from a given furnace area is important. There is no sense in making our furnaces larger than they should be. I believe most combustion and operating engineers will agree that the shorter the time that a piece of steel is in the furnace, the higher the quality of the finished product. In the last four or five years quite a few of our older furnaces and some relatively new furnaces have been rebuilt without changing the size of the furnace, either in width or length. In many cases, this rebuilding has increased the tonnage from the furnace as much as thirty-five to fifty per cent. This increase in tonnage was not obtained by race heating and burning down the furnaces by carrying excessive temperatures. It was done by maintaining proper elevated temperatures throughout the heating chamber at tonnage rates which heretofore was not possible. We have found out in the last ten years that steel can absorb heat without damage at rates much higher than heretofore considered possible. The question of heating faster is a problem for engineers to solve. It means exposing more surface area of a piece to temperature, if such can be done. And it means carrying elevated temperatures at those points in the furnace where the scale condition and the temperature of the steel are such that the steel can take the heat.

One fact that I wish to impress upon this audience is that fast heating is not bad heating. If fast heating is done properly, the quality and product yield will follow in direct relation. Likewise, the faster the heating, the more accurate the product temperature control must be. So in order to improve our heating practice more thought should be given to finding the best type of product temperature control that is obtainable. The proper approach to the solution has at least been started.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. OF

IRON AND STEEL ENGINEER

(Required by the Acts of Congress of August 24, 1912, March 3, 1933 and July 2, 1946)

Name of Publication: *Iron and Steel Engineer*, published monthly at Pittsburgh, Pennsylvania. (Report of October 1, 1949.)

State of Pennsylvania
County of Allegheny

Before me, a notary public in and for the State and county aforesaid, personally appeared T. J. Ess, who, having been duly sworn according to law, deposes and says that he is the editor of the *Iron and Steel Engineer* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.
Editor: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.
Managing Editor: None.
Business Manager: None.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

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T. J. ESS, Editor.

Sworn to and subscribed before me this 20th day of September, 1949.

G. WILLIAM JONES, JR., Notary Public.

(My commission expires February 9, 1951.)

A FOUR-HIGH REVERSING COLD STRIP MILL

. . . . driven back-up rolls enable the use of smaller working rolls, and with front and back tension, the result is a modern all-purpose mill . . . .

By LLOYD L. WILSON
Engineering Consultant
Cold Metal Products Co.
Youngstown, Ohio

▲ FOUR-high reversing cold strip mills are not new. M. D. Stone, in a recent paper, "Reversing and Tandem Cold Mills," 1947 Proceedings, Association of Iron and Steel Engineers, P 265, places the first 4-high mill for cold rolling, at Allegheny Ludlum in 1923. He stated also that reversing cold mills of the two high type, with dual tension reels, were first introduced in Germany, in the 1920's and that the 4-high reversing type with driven work rolls and reels was first installed in the United States in 1932. The first 4-high reversing cold mill in this country was installed by my company in 1923.

Since that time many mills have been developed by various designers and we have had time in which to try out and judge these different mills. Some were of the all pull type, and some a combination of pull and work roll drive. Some have been successful, and a number of them have proved to be impractical or very limited in the work they would handle. Most all have had some limitation that prevented their being entirely suitable as all-purpose mills.

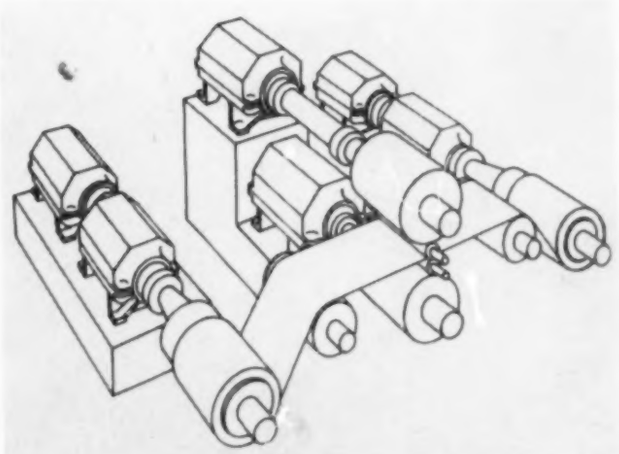
The Steckel all-pull mill used small work rolls and was intended to permit rolling to light gages at high speed. The small work rolls, with their small arc of contact, the anti-friction backing rolls and tension, permitted reductions on hard thin materials, thus eliminating intermediate anneals, reducing overall mill size and otherwise reducing first and subsequent costs, making possible overall total reductions and precision rolling of light gages previously unknown in any substantial width. However, since the tensile strength of the material being rolled dictated the magnitude of pull that could be applied, the percentage of reduction was generally limited to around 10 to 15 per cent, although greater reductions have been made. Even then broken strip limited production to some extent. These faults and the short life of the very small diameter rolls kept this mill from much more general usage, especially for rolling the more easily reduced metals.

Other mills, produced by the various well known manufacturers, used a combination of pull in the reels and drive delivered through the work rolls. Because a substantial part of the power was applied through the work roll necks, roll diameters were naturally large and became increasingly large as more speed and power were added. Reductions were thus limited to some extent, especially on high carbon and alloy steels and, to obtain better results, housings and screwdowns became quite large to overcome the tremendous roll pressures.

Obviously what was needed by the cold rolling industry was a mill that was really an "all-purpose" mill. With today's demands for higher production and lower costs, many are handicapped by old and obsolete equipment. Both objectives are in sight when the cold roller can make the greatest reductions, at highest practical speeds, using less massive equipment. He needs the advantage of the smaller diameter rolls and the power and speed of the larger mills. He must be able to vary the tension, both front and back, over a wide range, with smooth control. Mills must have adequate bearings, coiling reels that stand up and, with all, the ability to do precision work on all grades of steel, including high carbon, silicon, stainless and alloys.

During these years of development, designers have not foreseen one possible answer to the requirement — that is, the application of some power to the work rolls by driving the back-up rolls themselves, the remainder

Figure 1 — The sketch illustrates the roll and reel arrangement and the motors which are used in the design of a large mill.



Presented before AISE Annual Spring Conference, Buffalo, New York, April 26, 1948

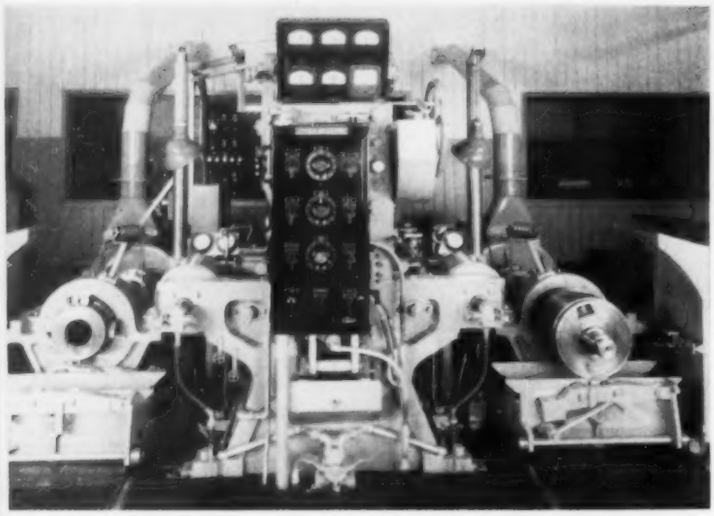


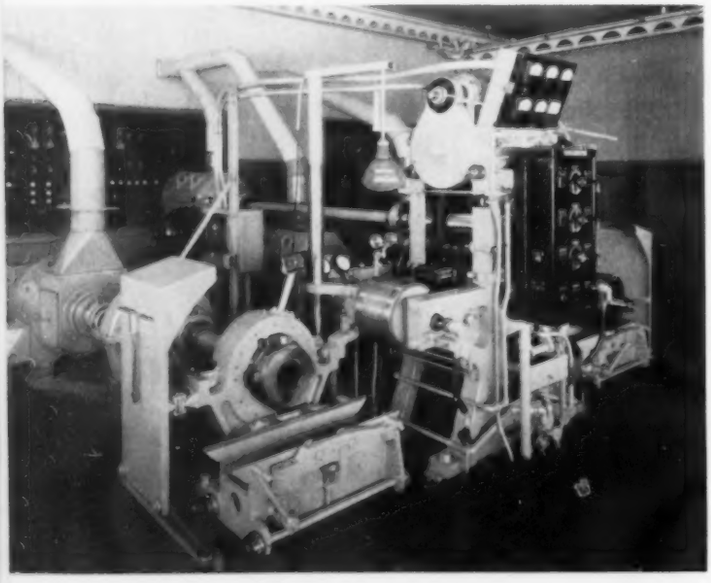
Figure 2 — Front view of experimental mill.

of the power being supplied by tension. Skilled engineers had decried the driving of backing rolls on the theory that there would be slippage between the work rolls and the backing rolls.

To prove the possibility, we decided to try to overcome the drive deficiency, strip breakage and other disadvantages of the all pull type of Steckel mill (including the lateral bowing out of the working rolls when more than a moderate reduction was taken) and to overcome well known deficiencies of the large, wholly or partly driven, working roll types of 4-high mills. A 10-in. mill was built, to serve as a finishing mill for light gage hard material, razor blade steel, stainless steel and silicon steel in particular.

This mill was completed and has been in regular production for over a year. It has work rolls 3 in. in diameter, back-up rolls 14 in. in diameter, a roll face of 10 in. Maximum rollable strip width is 9 in. Power is supplied by 50-hp motors driving each back-up roll and also 50-hp motors on each tension reel.

Figure 3 — In this view of the experimental mill the reel has been removed from the left side.



The results obtained were very gratifying and proved the soundness of the theory beyond all doubt. Many experiments were conducted, using 18-8 stainless steel, 3.3 per cent silicon steel and 1.25 per cent carbon steel. Reductions approaching those usually considered normal with low carbon steel could be made on these materials. Over 35 per cent reduction per pass have been made on the soft stainless, silicon and carbon steels and over 50 per cent on low carbon, and at no time did slippage occur. At around 65 per cent, slippage was encountered, between the strip and the work rolls, and this was held attributable to insufficient tension.

The 3 in. roll was adopted when it was found that the original 1¾-in. rolls did not stand up long enough, requiring too frequent regrinding. These smaller rolls were also too susceptible to the heat from the heavy reductions, and would not hold their shape. The 3-in. rolls have done very well, on both counts, and it is not surprising that they have proved to be more practical.

Production on this experimental mill (when rolling the thinner sizes) is from three to ten times that obtained from an almost duplicate mill of the all pull Steckel type in this same plant. The higher production rates are obtained when rolling the more difficult steels (silicon, high carbon and alloy) and particularly in the lighter gages. This is also true of the light gages of low carbon. Breakage and consequent delays have been greatly reduced. Indicative of the reductions which may be accomplished, it was found that when rolling low carbon from 0.020 to 0.006 in. this reduction could be accomplished in three passes. When rolling 3.3 per cent silicon steel from 0.025 to 0.010 in., three passes were also employed.

With such favorable results it was decided to build a larger mill, to be used as an all-purpose mill for general production. This mill has not yet been built nor has the design been completed. Progress is sufficient to permit a general description.

One general rule has been kept in mind. That is that "the best rolling efficiency is obtained when the heaviest practical reduction is made with the smallest practical work rolls at the highest practical speed." This puts a lot of burden on the definition for the word "practical"!

Taking general mill practice as a guide, the heaviest practical reduction will be somewhere between 40 and 50 per cent maximum. Most engineers and operators are content with this, especially on low carbon steel. Greater reductions would involve large unwieldy equipment, and expensive power and would introduce unreasonably difficult heat dispersion problems, and reductions beyond this figure would not materially increase production consistent with the capital expenditure involved.

Again experience is the dictator in selecting the smallest practical work roll. Mr. Sendzimir, in his recent paper "The Sendzimir Precision Cold Strip," 1946 Proceedings, Association of Iron and Steel Engineers, P 177, on his mill, has sponsored the use of very small work rolls. Mr. Stone, commenting on that paper, has a good defense for large work rolls. Neither one says how small or how large. Our company has used, on their various mills, rolls from 1½ to 8 in. in diameter. Undoubtedly larger rolls, while costing more, stand up better both for wear and sensitivity to heat. A compromise is of course necessary, because we expect to roll

the extremely light gages and also expect the mill to produce well on the heavier gages. Consequently a 6 in. diameter roll was chosen. With this size, the mill (28 in. in width) will be able to make the desired reductions and will roll the very light gages without too much difficulty. It is large enough to have a good surface life, is a good size to handle in grinding without steady rests and is large enough to take up considerable heat without undue distortion.

As for the practical speed of a reversing mill, much will depend on coil sizes to be handled, the gage to be rolled, size of the individual order or lot, surface requirements and gage accuracies desired. Heat dissipation also enters into it as well as the size and cost of the electrical equipment. For our mill, we have chosen 1800 fpm as the maximum speed. This is a good production speed, not difficult to control, and is higher

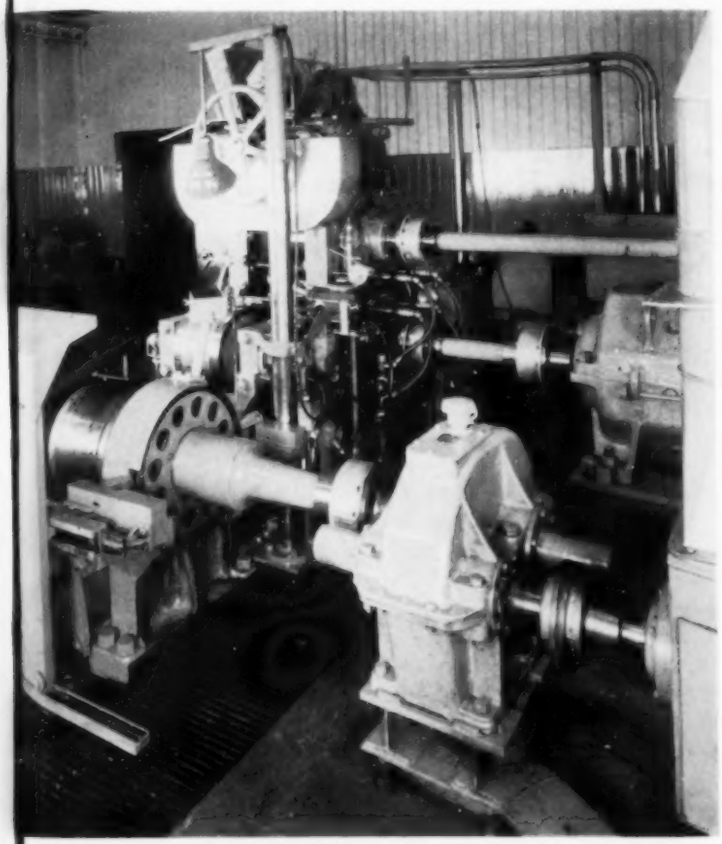


Figure 4 — View of back side of experimental mill.

than the speed at which most reversing mills of this width are operated.

Work roll diameter, bearing loads expected and work to be done, covering as it does the greatest possible variety of material, reductions and resistance to rolling, as well as the desire to provide a solid stiff mill, dictated a backing roll diameter of 34½ in.

Bearings are the double row radial roller type with end thrust adequately covered in both backup and work rolls. Rolls are 28 in. over the shoulders, to roll a maximum width of around 26 in.

Screwdown is of the wedge type, motor driven, is strong and positive, and perfectly satisfactory for the low lift necessary on a cold mill.

The housings have a window opening of 35 in. and a cross sectional post area of 255 sq in.

Cooling facilities are more or less standard, with plenty of provision for position and volume control of sprays. Mineral oil will be used as a coolant, though soluble oil can be substituted when found necessary. The oil is recirculated for cooling and filtering. Further aid for strip cooling is provided by the 24 in. diameter cooling guide drums. These drums are water cooled and definitely contribute to strip cooling.

The tension reels are bottom coiling, which allows inspection of both sides of the strip, gives a sharp break from the pass line and, consequently, a long arc of contact with the cooling drum. Reels are as close to the mill as possible, to reduce end losses. These reel drums are of the solid type supported by bearings at both ends. This avoids the detrimental effect of coil tightening and collapse, and provides a rigidly held level reel without the spring and resulting side pull of the usual reel supported on one end only. More uniform tension is possible and, consequently, more flatness in the strip. These reels produce a coil 26 in. inside diameter and, for our own use, will take coils up to over 400 lb per in. of width and up to 53 in. outside diameter.

These reels are rolled into position on their flanges and are locked to the driving shaft by means of a quick manually operated latch and lock system.

Most reversing mills use a collapsing reel, supported on one end only, and when coils are unloaded from the reels they sometimes collapse at the core because of compression due to strip tension. This is particularly true when rolling light gages. Moreover, most of the material, broken down to an intermediate gage, or if rolled to a finish gage, must be loosened or rewound before it can be box annealed. Additional equipment must be provided for the rewinding operation. Consequently this mill is equipped with a rollout floor track between the final delivery reel and a recoiling unit, with a turntable and side track to hold the empty third reel.

Coil feeding, or first pass speed, can be up to 1000 fpm depending on the type of feeding equipment chosen. Various methods can be used to hold the coil. For best results there should be some control over the back tension and some way to prevent the feed reel from over-running. The type and condition of the material being rolled will largely determine the installation best suited.

All conventional controls are provided for this mill. Generally, equipment of this size is set up with twin panels set back from the mill in desks for the operator. On this mill, controls probably will be mounted on the housings, or on a swing panel attached to the housings. This method has served satisfactorily on other mills.

As planned, this mill seems to be eminently suited to the intermediate reductions and for rolling to final gage. It will do as well as any for the first or breakdown passes and is completely flexible in its application for heavy, medium or light gage work, on all types of material.

For these reasons, it may be used as a breakdown mill or a finishing mill or both, and may be particularly

desirable for those who cannot afford, or whose tonnage does not justify, an individual mill for each purpose.

DISCUSSION

PRESENTED BY

JOHN E. ECKERT, Senior Engineer Armzen Co., Waterbury, Conn.

M. D. STONE, Manager Development, United Engineering and Foundry Co., Pittsburgh, Pa.

L. F. McCAFFREY, Engineer, Industrial Sales, Allis-Chalmers Manufacturing Co., Pittsburgh, Pa.

R. W. GRAHAM, Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

L. L. WILSON, Engineering Consultant, Cold Metal Products Co., Youngstown, Ohio

John E. Eckert: Mr. Wilson said he put a large burden on the definition of the word "practical" and I think he really meant it, because it is a very hard thing to say what is the most practical as regards speed and reduction. He has laid some stress on the fact that they built a mill to use 1¾-in. work rolls and then went back up to 3 in. because the 1¾-in. work rolls required too frequent re-grinding. In the sendzimir mill, we have successfully used work rolls going down to as small as ½ in. on an 8 in. mill and 1⅝ in. on a 37 in. mill.

The frequence of grinding rolls is not in direct proportion to diameter, due to the smaller contact with the metal and the less slippage on small rolls. In all sendzimir mills, the work rolls can be changed by hand very quickly. The roll is a simple cylinder with no work roll bearings and chocks. The sendzimir mill backing cradles the work roll and presents no problem from bowing. We are grinding rolls 2⅛ in. diam. × 42 in. long without the use of steady rests. These smaller work rolls permit the use of the highest quality tool steels and in some cases we find the use of carbide rolls practical.

We have been driving sendzimir mills by back-up rolls since 1944 and are now driving the larger mills on rolls twice removed from the work roll. We should like to point out that with the sendzimir mill we have four driven rolls and it is possible to transmit about 40 per cent more power before slipping.

M. D. Stone: The mill that Mr. Wilson has discussed has been one that we have been giving some thought to of late, and it comes about in general by a desire to use smaller work rolls. Now, where the work rolls are very large, it is no problem in driving the work rolls direct through gear drives or pinions, as usual, but there are advantages to be gained in smaller work rolls for certain applications. Just what the practical diameter is, is still to be determined, as Mr. Wilson stated.

The sendzimir mill has gone very low in diameter, and rolls of conventional mills, for certain applications, are probably larger than the optimum. For instance, in building the first sendzimir mills, for which we had the contract to construct the mill, we were interested in finding out what the facts were on power for rolling material with a small work roll. Some people had the erroneous idea that if you reduced pressure materially, it reduces the power very materially. By virtue of the reduction in pressure you reduce your friction on your mill, and insofar as that friction is a large or small part of your rolling load, it will reduce the horsepower somewhat.

In comparative tests on that first sendzimir mill in this country as against standard four-high mills with ten and twelve-inch diameter work rolls, the difference in power was insignificant. That is, the reduction in friction of the back-up rolls, by virtue of reduced rolling pressure, was very small, and Mr. Apperson's curves (see next paper) indicate the same thing.

But there are advantages to be gained, as I say, in the small work roll, provided you do not go too far, and that diameter is probably yet to be determined. You get to a point, particularly for wider material, where you cannot put all the power you require into the work rolls. At least you cannot put drives for both rolls on the same side of the mill, so you are concerned with other ways of driving the mill, such as driving the back-up rolls.

I would like to say in that connection that driving the back-up rolls is not a new arrangement. I think there are those of you who may have seen small four-high mills built by a company in New England at least twenty years old in which the back-up rolls are driven. The question, however, of the practicality of doing it is very much tied up with the type of lubricant or rolling oil that is involved. There are mills that are in very successful operation with a single driven back-up roll and going at very high speed. That is, all the power goes through a single back-up roll. There are mills in which a single work roll is driven. A tandem mill in the Chicago district has a mill that has one work roll driven, and it operates very well at over 2000 fpm with no slippage whatsoever.

The problem, therefore, is to evaluate the friction that you have available between the back-up roll and the work roll on the one hand, as against the power to be transmitted from the back-up roll to the work roll without slip on the other. In an experimental run, made recently on a standard tandem tin plate mill with only one work roll driven, slippage occurred between the non-driven work roll and the strip so markedly, that it ran at about 50 per cent of the speed of the driven roll. By that I mean that the undriven work roll was slipping and the lubricant was too good a lubricant to permit the transmission of the horsepower.

Now, the contacts between the strip and the work roll are more conducive to slippage than between the work and back-up rolls. That is, the surfaces conform more closely and you are more apt to get a good lubricating film. Whereas, in the case of a back-up roll and the work roll, the surfaces do not conform. They are opposed to each other, the friction conditions are better, and the chances of driving are considerably better in that case.

So, to sum the thing up, I would say this, that I heartily agree with what Mr. Wilson has done. I think the extension can be made to bigger and wider mills and in certain applications, particularly for pre-set mills where your pressure between your rolls is essen-

tially as high or practically as high without material in the mill, as it is with material in the mill, there should be no question at all of slippage.

I would like to ask Mr. Wilson, however, with regard to the heavier gages that he mentioned at the earlier passes, what was done to avoid the possibility of slippage upon entering. I presume that what he did was to put the strip in the mill and clear it to the reel and then bring the mill rolls together. In that case you could avoid it, but with a gap between your work rolls, being only held up against the back-up rolls by your balance system, you might run into slippage at the instant of entering, which might mark your rolls and, consequently, mark your strip. So there may be a point there with which to be concerned. That would be certainly true for a one-way mill, and in certain applications of stainless, for instance, where you are rolling expensive product you can take the time to be careful about it and thread before you bring the rolls together.

In general, however, I think the mill has merit and will be used more than it has to date.

L. F. McCaffrey: I would like to ask one question on the merit of bottom winding. The merit of bottom winding, as I understood it, was that you could see both sides of the strip. The speed of the mill is 1600 fpm, and traveling at 1600 fpm I find it is very difficult to make any observation as to what exactly goes on. It was said that the mill is operated by Ward-Leonard control, so you can reduce the speed of the mill, but everybody here understands that when you reduce the speed of a mill you also heavy up your gage, so what good is derived from bottom winding and making your gage heavier while you give it that inspection?

L. L. Wilson: I must answer that by saying that obviously you cannot inspect the strip when it is moving at anything over 250 or 300 fpm, and that inspection is a secondary consideration.

There is an inspection always on the reversing mill and you like to know what you are doing; but of course you have to see the strip when you start or when you are running slow enough to see it.

The important thing here is to get the strip down closely over what I call the cooling roll, or the billy-roll and then, holding over that roll for a long arc of contact, you get a longer contact with the roll which is very cool, and which helps take some of the heat out of the strip. By bottom coiling you are always hugging the strip down, you are always cooling, you are always passing over your billy-roll to the bottom side of the coiler. Inspection is possible, both sides of the strip, when you want to do it.

L. F. McCaffrey: I think that clears up the question. I just wanted to bring up the point that really you do not get any inspection that is worth anything, because any inspection that you get has to be at reduced speed, which gives you immediately off gage material coming out of your machine, is that correct?

L. L. Wilson: That is right.

R. W. Graham: Could you tell us what percentage of the total rolling time that you are either accelerating or decelerating?

L. L. Wilson: The exact percentage I cannot tell you, except that I will mention our most recent Steckel mill, one that was built about three or four years ago. On that mill the acceleration and deceleration was measured in a very few seconds, which we hope to have duplicated on this new mill we are designing. One thing we are asking our electric supplier for is rapid acceleration and deceleration; it is a very necessary and very important part of production.

WANTED!

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ELECTRICAL FEATURES OF FOUR-HIGH REVERSING COLD STRIP MILL

By J. S. APPERSON, III
General Electric Co.
Cleveland, Ohio

. . . . the electrical equipment on this type cold, reversing mill is basically similar to most well-known reversing, cold strip mills . . . .

▲ This paper will: 1. briefly describe the electrical equipment used on an existing 10-in. mill; 2. discuss the tests conducted on this mill; 3. compare the results of these tests with the results of tests taken on other cold mills; 4. show how the test data can be used in determining the power requirements of the proposed 28-in. mill; and, 5. briefly describe the electrical equipment that might be used on the proposed mill.

1. ELECTRICAL FEATURES OF EXISTING 10 IN. MILL

The existing 10-in. mill has a 50-hp, 375/405-rpm, 230-v mill motor direct connected to each back-up roll. The winding reels are each powered by a 50-hp, 300/1200-rpm, 230-v industrial type motor. Power is supplied to the motors from a 5-unit motor-generator set. The schematic power circuit is shown in Figure 1.

This electrical layout differs only slightly from the electrical layout used on a conventional, reversing cold strip mill. Separate reel generators were provided to take care of the required draft of up to 50 per cent but boosters could have been used. Had boosters been used, they would each have been rated approximately 150-v, 30 kw.

Load balance between the motors driving the top and bottom back-up rolls was obtained through the use of armature circuit resistors in addition to the inherent drooping characteristics of the motors themselves. This scheme has proved satisfactory and it has not been necessary to add any load balance regulators.

It is interesting to note that with the mill rolls ground to normal tolerances, the roll diameter adjusting rheostat can be adjusted in such a manner that the motor armature currents will be unbalanced as much as 15 per cent. This was done as an experiment without any observable slippage or marking of the strip occurring.

The physical arrangement of the twin motor drive on the mill is of interest. The mill motors were selected primarily because of their small diameter, and the ease with which they fitted into the arrangement is shown in Figure 2.

It so happened that an additional advantage was derived from the use of mill motors. This motor has a generous overload capacity, and this extra capacity enabled the operators to roll schedules beyond the designed capacity of the mill. These schedules were rolled for the purpose of accumulating data for this paper. Observations made during a number of heavy passes showed the motors operating at over 200 per cent load without stress. In fact, only slight sparking was observed on the commutator of the main generator.

Although the overload capacity of these motors was of benefit in obtaining the data for this paper, the use of this type of motor is not necessarily recommended, especially on reversing mills where the motor field must be weakened to any appreciable extent.

2. TESTS CONDUCTED ON THE 10 IN. MILL

A series of tests were conducted on the 10-in. mill while the mill was rolling low carbon, high carbon, silicon and stainless steel. The data derived from these tests has been tabulated and curves of horsepower-hours per ton versus strip thickness have been prepared to show the power requirements of the 10-in. mill. The procedure for deriving the data from which the curves were plotted was as follows:

A. Strip width and thickness were measured before and after each pass.

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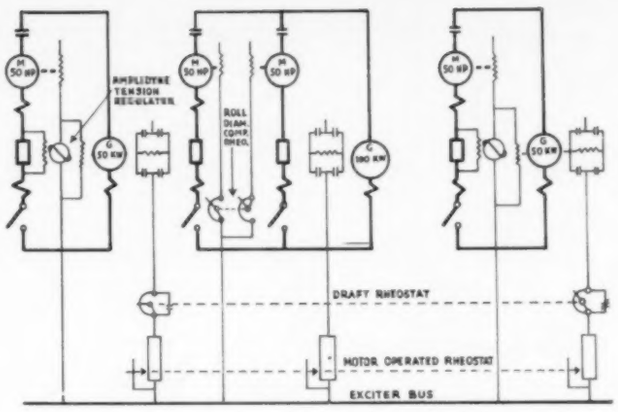


Figure 1 — Schematic power circuit of existing 10 in. mill.

B. Readings of voltage and amperes for each of the mill motors and each of the reel motors were taken simultaneously during each pass and a reading of indicated strip speed was taken at the same time. As a check on these readings, recording wattmeter readings were taken for each motor and recording tachometer readings were taken of mill speed.

C. The power input to the mill was calculated by subtracting the approximate total mill motor electrical losses from the total kw-input to the mill motors.

A similar procedure was followed for the reels except that mechanical losses were also subtracted from the output of the winding reel motor and mechanical losses were added to the output of the unwinding reel motor. These mechanical losses were obtained by making running light tests on the reels alone and, though they are not strictly accurate, they are sufficient for the purpose.

D. The net horsepower required to reduce the metal was obtained by adding to the net mill horsepower the net winding reel horsepower and subtracting the net unwinding reel horsepower.

E. The net tons per hour rate of rolling is obtained by multiplying the area in square inches times the speed in feet per minute and dividing by 9.82.

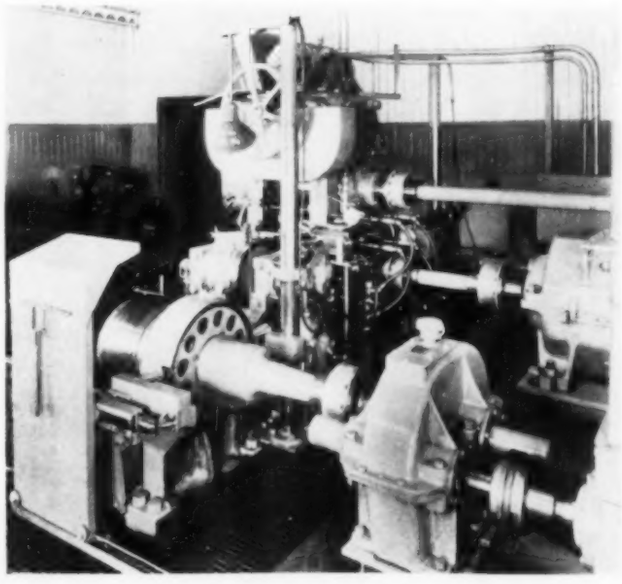
F. The horsepower-hours per ton per pass was obtained by dividing the net horsepower by the tons per hour per pass.

G. The total horsepower hours per ton was a summation of the horsepower hours per ton per pass.

The results of these calculations were put in convenient form by plotting a curve of thickness versus horsepower hours per ton and these curves are shown in Figure 3. Curve A of Figure 3 shows the power required to roll low carbon steel (0.07 per cent carbon) from 0.035 to 0.015 in. Curve B of Figure 3 shows the power required to roll high carbon steel (1.25 per cent carbon) from 0.028 to 0.012 in. Curve C of Figure 3 shows the power required to roll 3.3 per cent silicon steel from 0.025 to 0.012 in.

Since the entering gage differs in these three cases, we cannot compare these curves on an absolute basis. We can, however, compare the slope of these curves to get an idea of the relative power requirements for the various types of steels rolled. To exemplify this, Curve D of Figure 3 has been drawn to show the estimated power requirements for rolling 3.3 per cent silicon steel from 0.035 to 0.012 in. thickness. If we compare Curve D with Curve A, we get an indication of the relative power required to roll silicon steel as compared to low carbon steel. This comparison shows that approximately 50 per cent more power is needed for rolling high silicon steel than is needed for rolling low carbon. In a like manner, we can compare the power curves for high carbon steel with the curves for low carbon steel and find that it takes approximately 30 per cent more power to roll the high carbon or razor blade steel than it takes to roll mild steel. We had hoped to obtain similar data on rolling 18-8 stainless steel, but we were not able to accumulate sufficient data to include in this paper tests on rolling stainless. We anticipate, however, that it will require approximately 75 per cent more power to roll 18-8 stainless than is required for rolling low carbon steel.

Figure 2 — The back side of a 10 in. reversing cold strip mill is shown in this view.



3. COMPARISON OF POWER REQUIREMENTS

In order to compare the power requirements of the 10-in. mill with the power requirements on other four-high cold mills, Figure 4 was prepared. Curve A in Figure 4 is the same as Curve A of Figure 3 and shows the power required to roll low carbon steel from 0.035 to 0.015 in. on the 10-in. mill. Curve B of Figure 4 shows the power required to roll 0.085 in. low carbon steel to 0.0106 in. and was plotted from tests taken on a conventional four-high mill. It is interesting to note that even though there is a wide variance in width, speed and gage in these two cases, the curves are very similar and have almost identical slopes.

A comparison of the tests made on the 10-in. mill with tests made on other mills with small work rolls, and other mills with relatively large work rolls indicate very little difference in the power requirements for these different types of mills. In general, it is safe to say that

the data given here, or other existing data may be safely used for determining the size of motors to be applied on larger mills of this type.

It might be well to point out, however, that caution should be used in using power curves to select motors for rolling high silicon and stainless steels. Annealing and work hardening play such an important part in determining the required power that considerable attention must be paid to the starting thickness, the extent of the reduction and the type of anneal.

4. POWER REQUIREMENTS OF PROPOSED 6 IN. AND 34½ IN. BY 28 IN. MILL

To determine the power requirements of the proposed mill, let us assume that we wish to roll the following schedules:

Schedule No. 1—Mild Steel — 24 in. wide — from 0.083 to 0.010 in. — at a maximum speed of 1800 fpm — 5 passes.

Schedule No. 2—Mild Steel — 26 in. wide — from 0.072 to 0.020 in. at a maximum speed of 1800 fpm — 5 passes.

Schedule No. 3—Mild Steel — 26 in. wide — from 0.025 to 0.006 in. — at a maximum speed of 1800 fpm — 3 passes.

Schedule No. 4—3.3 per cent Silicon Steel — 26 in. wide — from 0.025 to 0.010 in. — at a maximum speed of 1800 fpm — 3 passes.

From power curves similar to the curves shown in Figures 3 and 4, we can obtain the power required per pass to reduce the strip as specified. Winding reel tension has been assumed to be approximately 10,000 psi and unwinding reel horsepower has been taken as one-third of the winding reel horsepower except on the first pass. It is expected that some type of coil holder will be used to pay off the strip for the first pass and in this case, a back tension horsepower equal to one-fifth of winding reel horsepower has been assumed. Based on this information, we obtain the data which is tabulated in Tables I, II, III, and IV. For the sake of brevity, we will discuss only Table I which covers Schedule No. 1.

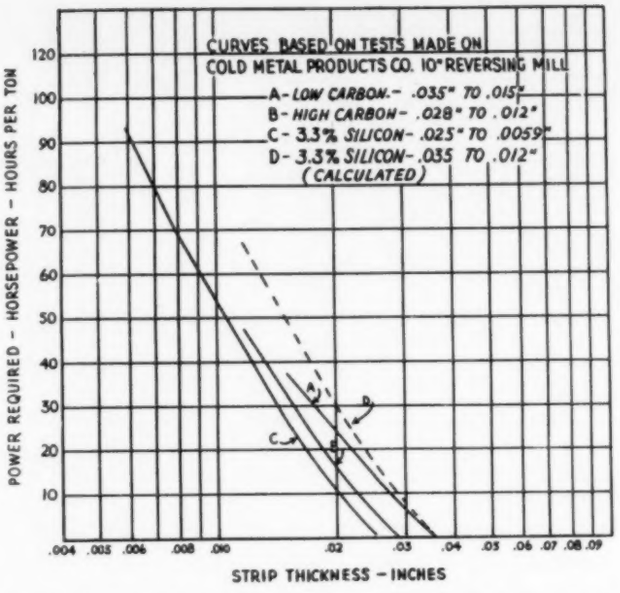


Figure 3 — The power required to reduce cold strip on the new 10 in. reversing mill is given in these graphs.

TABLE I

Tabulation of data used in determining power requirements of Schedule No. 1 — Rolling Mild Steel, 24 in. wide from 0.083 to 0.010 in. in 5 passes

	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5
1. Delivery Gage	054	035	023	015	010
2. Speed	600	700	1000	1400	1800
3. Tons/hr	79.2	59.6	56.1	51.5	43.0
4. Hp-hr/ton	15	18.5	19.5	21.0	21.0
5. Total hp	1185	1100	1090	1080	905
6. Reel hp	190	119	111	102	87
7. Mill hp	995	981	979	978	818

TABLE II

Tabulation of data used in determining power requirements of Schedule No. 2 — Rolling Mild Steel, 26 in. wide from 0.072 to 0.020 in. in 5 passes

	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5
1. Delivery Gage	054	040	030	024	020
2. Speed	700	800	1000	1600	1800
3. Tons/hr	100	84.8	79.5	102	95.5
4. Hp-hr/ton	11.5	12.5	14.5	10.5	8.5
5. Total hp	1150	1060	1050	1070	810
6. Reel hp	236	169	158	202	189
7. Mill hp	914	891	892	868	721

TABLE III

Tabulation of data used in determining power requirements of Schedule No. 3 — Rolling Mild Steel, 26 in. wide from 0.025 to 0.006 in. in 3 passes

	Pass 1	Pass 2	Pass 3
1. Delivery Gage	013	008	006
2. Speed	1200	1800	1800
3. Tons/hr	41.4	38.1	28.6
4. Hp-hr/ton	26.5	23.5	14
5. Total hp	1100	895	400
6. Reel hp	99	76	57
7. Mill hp	1001	819	343

TABLE IV

Tabulation of data used in determining power requirements of Schedule No. 4 — Rolling 3.3 per cent Silicon Steel, 26 in. wide from 0.025 to 0.010 in. in 3 passes

	Pass 1	Pass 2	Pass 3
1. Delivery Gage	016	012	010
2. Speed	1200	1800	1800
3. Tons/hr	50.8	57.0	47.7
4. Hp-hr/ton	22	19	13
5. Total hp	1120	1090	620
6. Reel hp	122	114	95
7. Mill hp	998	976	525

Table I contains the following data:

A. Line 1 shows the delivery gage for each pass.
B. Line 2 shows the proposed delivery speed for each pass.
C. Line 3 shows the production rate per pass in tons per hour and is determined by multiplying the delivery thickness times the width times the delivery speed and dividing by 9.82.
D. Line 4 shows the estimated horsepower hours per ton per pass and is obtained from curves similar to those shown in Figures 3 and 4.
E. Line 5 shows the horsepower per pass required to reduce the strip and is the product of tons per hour and horsepower hours per ton.
F. Line 6 shows the reel horsepower available for reducing the strip and is obtained by subtracting from the calculated winding reel horsepower the calculated unwinding reel horsepower.
G. Line 7 shows the calculated required mill horsepower and is the difference between Lines 5 and 6.

5. ELECTRICAL EQUIPMENT FOR THE PROPOSED MILL

From the data tabulated in Table I and also Tables II, III, and IV, Figure 5 has been prepared. In this figure, mill horsepower is plotted against speed for each of the passes tabulated in Tables I, II, III, and IV. From the points plotted, it is seen that the proposed mill will require 1000 hp from 600 to 1800 fpm. Since the back-up roll diameter is 34½ in., if the motor is to be direct connected to the back-up rolls, it must have a speed range of approximately 70/210 rpm. To individually drive each back-up roll, two motors, each rated 500-hp, 70/210 rpm, are required, and since these motors must be mounted on 46½ in. centers, each 500-hp motor will be a double armature unit.

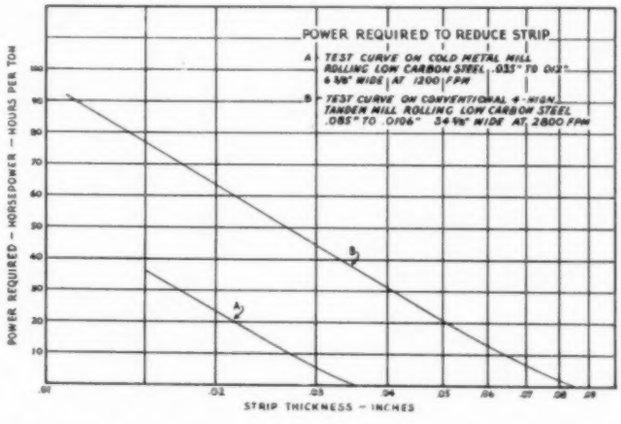

POWER REQUIRED TO REDUCE STRIP
A - TEST CURVE ON COLD METAL MILL ROLLING LOW CARBON STEEL .035" TO 0132" 6 5/8" WIDE AT 1200 FPM
B - TEST CURVE ON CONVENTIONAL 4-HIGH TANDEM MILL ROLLING LOW CARBON STEEL .085" TO .0106" 34 5/8" WIDE AT 2800 FPM
POWER REQUIRED - HORSEPOWER - HOURS PER TON
STRIP THICKNESS - INCHES

Figure 4 — The power required to cold reduce mild steel on the conventional mill is much greater than that on the new type mill.

The winding reel on the proposed mill has an inside diameter of 26 in. and an outside diameter of 53 in. Based on a delivery speed of 1800 fpm, it will be necessary for the winding reel to have a speed range of 130/255 rpm. The reel motor must have a speed range approximately 20 per cent greater than this to allow the tension regulator freedom of action. We might, therefore, select a 3 to 1 direct connected reel motor with a speed range of 100/300 rpm. On the other hand, we might decide to incorporate a gear reduction unit and use a somewhat higher reel motor speed. Direct connected reel motors have shown themselves to have very definite advantages from the standpoint of minimizing the inertia for acceleration and deceleration, and from the standpoint of minimizing the changes in mechanical losses during the build-up of the coil diameter.

When a constant current regulator is used for controlling the tension, the changes in mechanical losses due to windage and oil pumping, for instance, result in a change in tension since the regulator is unable to tell the difference between tension load and load due to losses. Mechanical tensiometers have been used to eliminate this difficulty on some mills, but on mills of this particular type there is not enough room to mount existing types of tensiometers.

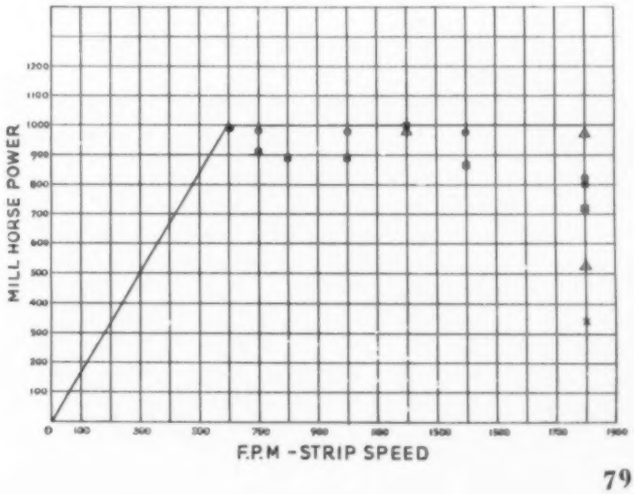
An examination of the rolling schedules will indicate that the winding reel motor must be capable of delivering 700 hp at 1800 fpm and rated voltage. The tension horsepower shown in the tabulations is less than the rated 700 hp because the available tension horsepower decreases in proportion to strip speed, although the motor may be delivering its rated torque. For example, in Schedule No. 1, pass No. 1, the reel horsepower is calculated as 240 hp at 600 fpm. This represents full load on the motor since the applied voltage is reduced by the approximate ratio of 600 to 1800 fpm.

Since this is a reversing mill, and the reels are alternately winding and unwinding, both reel motors should have the same rating.

Experience has shown that the practical limit of tension which can be satisfactorily maintained by a constant current regulator is about 10 to 1. Several methods are available for increasing this range. One of the most practical methods is to couple two motors to each reel with a mechanical means of disconnecting one of the motors completely when very light tensions are required.

An examination of the rolling schedules shows that on the basis of the torque required for unwinding and winding tension, a range in tension of approximately 17 to 1 is required. Since this exceeds the practical limit of a constant current regulator used with a single reel

Figure 5 — This chart was used to determine motor hp and speed for mill.



motor, and since available tensiometers are not adaptable to the mill, the use of double motors on each reel is advisable.

The remainder of the electrical equipment for the proposed mill will be similar to that used on the 10 in. mill although increased in size to suitable capacity. Since the mill motors are to have a 3 to 1 speed range by field control, load balancing regulators should be incorporated. As on all mills of this type, all of the main motors and generators should be provided with forced ventilation.

CONCLUSIONS

From the foregoing discussions, it is evident that the problems encountered in applying electrical equipment to this new type of four-high mill are similar to those encountered on all well-known reversing cold strip mills. Operating experience on the 10-in. mill, as well as experience on a number of mills of different makes, have demonstrated the practicality of driving the back-up rolls on cold reduction mills. Earlier in the paper, it was stated that no observable slippage or marking of the strip had occurred when the relative currents in the individual roll drives were offset approximately 15 per cent while the mill was rolling a normal schedule. Further evidence that individual roll drives on cold mills are practical was furnished from a test experiment on the world's fastest tandem cold strip mill. Work rolls having a ¼ in. difference in diameter were installed on the last stand and while rolling tinplate at a speed of 4800 fpm, no strip marking or chatter was observed.

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DISCUSSION

PRESENTED BY

L. R. MILBURN, Consulting Electrical Engineer, Whitmore Lake, Mich.

J. S. APPERSON, III, General Electric Co., Cleveland, Ohio

P. H. McCONAGHEY, Electrical Engineer, Vandergrift Plant, Irvin Works, Carnegie-Illinois Steel Corp., Dravosburg, Pa.

H. W. BARTLING, Metal Rolling Engineer, West Allis Works, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Loyal R. Milburn: Mr. Apperson's paper will be of considerable help in connection with calculations on future mill installations. I would like to make a few comments about this subject. Under the heading of horsepower calculations, the tension is always assumed as 10,000 psi. This makes an easy starting point but actual practice does not bear out this assumption. Why not make some accurate tension tests and check the actual tensions on a group of installed mills?

Perhaps it would be advantageous to the industry and to the Association of Iron and Steel Engineers to spend some money and time on a research project to actually run tests on two or more cold reduction mills of each type to determine the proper curves for mill calculations. We know that widths, entering thickness, speed, tension and class of mill (size) all require different rates of horsepower hours per ton. The cold reduction art has now progressed to the point where I believe we should develop suitable curves to fit all conditions of rolling. In other words, let us eliminate the guess work and perform our calculations from actual power curves. From my past two years experience, I am convinced that we cannot develop one universal curve. It will require the developing of a family of curves from which suitable working curves can be derived or interpolated to suit new conditions or rolling schedules as they arrive.

Member: I would like to ask Mr. Apperson one question. He shows that the winding reel reduces the load on the main motor a hundred horsepower. That is a little higher winding tension than I would expect. I wondered if there was any particular reason for having rather high tension on the delivery side?

J. S. Apperson, III: In calculating the power requirements of the proposed mill, winding reel horsepower was based upon an assumed strip tension of 10,000 psi. Operating factors will, of course, dictate the actual tension requirements.

P. H. McConaghey: You made the statement that the back-up roll is thirty-four and a half inches in diameter. That would be roughly nine feet around the circumference. If the base speed of that motor was 70 rpm on direct drive, that would be a little better than six hundred feet.

J. S. Apperson, III: No, six hundred feet per minute is the minimum rated speed and is the basic speed of the motors. The motors are on the Ward-Leonard adjustable voltage control system. The mill can be operated at any speed up to 600 fpm by voltage control and above 600 fpm by weakening the mill motor fields.

H. W. Bartling: In Mr. Apperson's comments he mentioned that they had as much as fifteen per cent load unbalanced between the upper and the lower roll drive. Later on, he mentioned the use of a current regulator, or rather a load balancing regulator. We have not supplied a drive for this particular type of mill so I am rather reluctant to comment too far, but it strikes me that in past performances, this question of load balance has given us considerable difficulty, even to the point of supplying an individual generator for a top motor roll drive and an individual generator for a bottom roll drive.

J. S. Apperson, III: On the existing ten inch mill there is no automatic load balance regulators. There are armature circuit resistors which tend to balance load, but the manipulation of the roll diameter compensating rheostat enabled us to unbalance the current in the motors by the fifteen per cent.

TRAINING MEN AT BETHLEHEM STEEL COMPANY

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. . . . one of the pioneers in training men for steel plant operations is the Bethlehem Steel Company whose program is covered in this paper . . . .

▲ IN discussing training programs carried out by Bethlehem Steel Co., it seems that the relationship of the company's organization to training may be of interest.

How does the training function fit into the organizational set-up?

Bethlehem's various activities or functions are carried out under the direction of the appropriate vice president in charge. Thus, a vice president is in charge, respectively, of steel plant operations, of shipbuilding and of raw materials. Other vice presidents include those in charge of the other various activities, such as: sales, purchasing, accounting, finance, transportation and industrial and public relations.

The plant general managers report to the vice president in charge of steel plant operations. Management responsibility in shipyards and mines is similarly established. The plant general manager is solely responsible for the plant's operation, including training.

The training function in the general organization is under the direction of the manager of personnel, reporting to the vice president in charge of industrial and public relations. Matters concerning training from the vice president in charge of industrial and public relations reach the various plants, shipyards and mines through the particular vice presidents in charge of those operations.

Thus, it is seen that the relationship between the industrial and public relations department, which includes the training phase of our personnel work is a functional one.

Presented before AISE Pittsburgh District Section Meeting, November 8, 1948

Each of the operations maintains its own training facilities which are sufficient to meet its own needs. The training personnel engaged at an operation may vary in number from one person to a staff of several persons.

The training facilities at the plants, shipyards and other operations are determined in relationship to the job to be done. It can be readily recognized that in the steel plants in pure steel-making activities, relatively little training can be given away from the job itself. On the other hand in the cases of jobs which require relatively more theoretical knowledge, it is sometimes possible to train people away from the actual work. Preliminary training may be given on certain machines, whereas a mill is just too big to be moved around for instructional purposes. Generally speaking, in our training programs we attempt to do as much training on the actual job as it is possible to do.

The elaborateness of training programs is thus dependent upon the kind of work to be done and speed with which new people must be trained, the availability of workers skilled in certain jobs, and other factors.

Bethlehem's training programs might be broadly classed into four major groupings: 1. Apprentice training; 2. College graduate training; 3. Learner training, and 4. Special or supplementary training.

APPRENTICE TRAINING

The apprentice training programs of the company have been of long standing. The first organized apprenticeship program with Bethlehem originated at

Fore River Shipyard, now the Quincy Yard, in 1900. In 1901 an apprentice program was begun at the Bethlehem steel plant, at Bethlehem.

There are now 1200 apprentices in all the shipyards and steel plants of the company. Of these, 900 are in steel plants and 300 in the shipyards.

The apprentice program as it is conducted in the Bethlehem organization covers a training of approximately four years, or 8000 hours to be specific, during which the apprentice is given a thorough training in both practical and theoretical aspects of the particular trade into which he is to enter. When an individual enters an apprentice course he does so as a probationary apprentice with the understanding, subject to his satisfactory performance throughout the course and his own desires during the probationary period, that he will complete his apprenticeship in his trade at certain specified rates of pay for each of the 1000-hour periods of his course. Upon satisfactorily completing his course, the apprentice is awarded a cash bonus of $200.

During the entire course, the apprentice spends approximately 4 hours per week in classroom work, studying the theoretical aspects of his trade and using as text material either courses set up by the local training department or a correspondence school course especially designed for his particular trade. He must satisfactorily pass each part of his training in order to qualify for his trade at the completion of the course.

In order that each apprentice be trained in every practical aspect of his trade, a schedule of processes is set up covering every part of the work time. The apprentice must spend an allotted time on each of the parts of his trade. The steel plants at present conduct apprenticeships in 20 different trades while shipyards conduct them in 21 different trades. They include more or less universal trades such as machinist, boiler-maker, carpenter, tool-maker, all of which are common to both shipyards and steel plants as well as more specialized training, such as ship-fitter or mold loft which are peculiar only to the shipbuilding industry.

The apprenticeship requirements of the plants originate in the departments which will need the skilled craftsmen. The plant manager approves hiring of a class which is started in its training after careful examination of qualified candidates. Qualifications are based on age, education, personality and physical fitness. High school or vocational school graduates are preferred, although applicants who have completed the 10th grade of the public school system are eligible for consideration. An applicant must be at least 18 years of age and must not have passed his 22nd birthday except in the case of veterans of World War II whom it is felt should not have passed the 23rd birthday prior to entering the service. Upon entering apprentice training, the enrolled applicants each serve a probationary period of 500 hours which is later considered a part of the total course provided he is satisfactory and wishes to continue in apprenticeship. At this point the applicant, and his parent or guardian in the case of a minor, execute an apprenticeship agreement with the company and the applicant becomes a duly qualified apprentice.

Since apprentice training is divided into shop instruction and text material, it is evident that shop and classroom instructors are needed. The shop instructors are selected men of practical experience and thoroughly trained who are capable of teaching and handling young men. These instructors are responsible to their respective department heads who, in all matters pertaining to the training and instruction of apprentices, cooperate with the supervisor of apprentices. The supervisor of apprentices who is on the staff of the industrial relations department at each plant is responsible for coordinating the apprentice program with the departments involved, and in supervising study of text and related pertinent material. Records, reports, and data on grades, conduct, attendance and progress of apprentices during the entire four-year duration of the course are recorded by the department and by the supervisor of apprentices. Such quarterly reports of progress as may be of interest to the parent or guardian are sent to keep him informed of shop and classroom progress.

Clerical work in keeping data on each apprentice is, of course, maintained by the supervisor of apprentices and one or more full-time instructors and clerical people he may have on his staff.

Of course, apprentices work regularly-scheduled hours and are subject to company rules applicable to other employees so far as punctuality, attendance and similar matters are concerned. Should he lose time from his work due to illness or other reasons, arrangements can be made to adjust the schedule. One phase of adjustment of the apprentice time schedule is worthy of note. In certain cases of special service training by the armed forces, apprentices have been given credit toward their 8000-hour course, but only upon proof of ability and service records and agreement with the department head involved.

The results of apprenticeship training over a period of almost 50 years has demonstrated its effectiveness in providing qualified workmen and in enabling many employees to advance themselves to positions of greater responsibility.

COLLEGE GRADUATE TRAINING

The second broad training program is that for college graduates, which we call the loop course. This program had its beginning around the turn of the century when steel-making began to evolve from a rule-of-thumb, hit-or-miss stage into its present stage of highly technical production and treatment. In a few years, one or more college men were taken into the organization each year. Finally, in 1922, an organized program was inaugurated through which a group of college graduates was taken into the organization and put through a regular course of intensive training.

In the early years of the program it was known as the "Probationary Observation Circuit" but as time went on and groups went through the plant, the men in the course became known as "loopers" because they "looped" through the different departments. The course, therefore, now has the official designation of "The Loop Course."

The group entering the loop course each year is recruited from among the principal technical colleges and universities. Personal interviews are conducted at the various educational institutions by representatives

of the personnel department. Each year about 60 of such institutions are visited.

In 1948 a total of 109 loopers were enrolled and subsequently assigned to divisions of the company. Since 1922, the average size of the group recruited has been 70 each year the course was operated. Probably the group to be recruited in the coming year will be close to 100 composed principally of engineering graduates.

During the summer following their graduation, the group is gathered at Bethlehem to begin its initial or broad training, in which it is desired to acquaint the college graduate with the functioning of the Bethlehem organization and an intensive observation training of steel plant operation at the Bethlehem plant. Normally, the group spends five weeks at Bethlehem during which time one hour each day is devoted to talks by the principal officials and department heads of the Bethlehem general organization. The balance of each day is spent in the plant in the observation of operations. Each day the looper is required to answer comprehensive quizzes on his plant visits. These quizzes are strictly graded.

At the conclusion of this basic training, each individual is assigned to the branch of work he expects he will follow during his career. For example, the men entering steel plant production are assigned to one of the steel plants. Sales loopers are assigned to the sales department. Accountants are assigned to the accounting department.

Thereafter, they begin the second phase of their training which is a specialized training designed to fit these college graduates into the actual work they will follow with Bethlehem. This period of training may vary from two months to one year in steel plants, and from one to one and one-half years in sales work and in varying periods up to one year in other specialized fields. This training is also broad. The third phase of the looper's training is on the job itself. He is assigned to a particular job within one of the plant departments, shipyard departments or other divisions. From then on he progresses solely upon his merit and the opportunities available.

LEARNERS

The third broad group under training is that of learner training. Learner training is primarily concerned with the teaching of individuals to do certain jobs which are limited in scope.

For example, most of the skilled special purpose workmen in the steel plants are trained through this method. The method is simply that the individual starts as a helper or some other class and progresses in stages of increased skill and scope.

In the progress of this training the individual begins under the close supervision of a skilled workman. Less and less supervision and teaching is carried out by the skilled workman until the operator is entirely on his own. This comes about through four distinct steps. First, the learner is under the constant supervision and instruction of the skilled operator; (2) the learner is allowed to perform minor operations by himself and observe more difficult operations; (3) the learner is able to perform more and more difficult operations by himself, but always under the direct observation and instruction of a skilled operator; and (4) the learner performs the job himself, under supervision.

SPECIAL AND SUPPLEMENTARY TRAINING

The fourth group in training programs is one which in many cases overlaps the other training programs. This group we will call the special or supplementary training program. It may be handled by instructors who are other employees of the company or given in established schools by their instructors. It includes courses all the way from elementary mathematics to highly specialized courses on such technical topics as metallurgy. Examples of these programs are courses of instruction in metallurgical engineering conducted at Bethlehem by Penn State College. In this case, the instructors are usually skilled metallurgists who are employees of the Bethlehem plant. Other special courses include pre-employment courses conducted in vocational schools covering such subjects as blueprint reading, shop mathematics, operation of machine tools, electric arc welding, bench work, sheet metal work, to name a few.

PLANT MANAGEMENT CONFERENCE PROGRAM

In Bethlehem's steel plants, the long established procedure of conducting departmental supervisory meetings was placed on a more intensive basis in 1945. The plants conduct informal conferences which provide a two-way means of communication for supervision to aid in doing the day-to-day job and to give them a more regular opportunity, and encouragement, to express to top management whatever suggestions or questions they may have.

An assistant to the general manager is charged with administration of the program at a plant. He follows all matters affecting supervisory forces and arranges through departmental superintendents for the scheduling of regular conferences in each department. The activities coincide wherever possible with departmental conferences on such matters as safety, construction, etc. In addition, his activities include cooperation with supervisory clubs and arranging any activities for participation by supervisory forces of an entire plant as a group. This coordination of conferences has as its objective a closer knitting together of management people informed as to developments in company policies and practices.

Since many problems can arise which interest supervision, it is necessary for the program to have close and full attention by the general manager's staff and the plant superintendents. It is of vital importance to operating problems that departmental supervisory forces interchange of ideas be applied within the departments to obtain the best results.

This discussion has been a brief attempt to outline the general training programs in effect at operations of the Bethlehem Steel Co. It has been my desire only to present the general picture and hope that your inquiries may bring out points of particular interest.

TRAINING MEN AT REPUBLIC STEEL CORPORATION

By JOSEPH S. KOPAS
Training Counselor
Republic Steel Corp.
Cleveland, Ohio

. . . . the training of technical operating personnel at Republic Steel is extremely thorough and well planned . . . .

▲ WE are all aware of the fact that training programs can and often do become costly, burdensome and lose much of their effectiveness because they are not or cannot be tied in with the basic personnel objectives of the company and because they lack the practical organization and direction.

Fortunately, at Republic Steel the training programs have been geared into the basic personnel objectives of the corporation, and the practical organization and direction has been provided the programs by the line organization.

The management at Republic Steel is making a sincere and determined effort to do a meritorious job of:

1. Selecting employees for job openings who will fit into the organization.
2. Placing them on jobs for which they are best suited and in which they have the best chances of succeeding, and
3. Providing them with maximum possible opportunity for progressing on the job on the basis of merit, experience and qualifications.

The training programs are in step with these personnel objectives. In fact, they are helping to spearhead the efforts of management.

To insure practical organization and direction, the training programs represent the best available experience of persons in steel making and in the operation of the steel business. The training function thus becomes a basic and essential function of management carried out by the line organization.

At present the following training programs are in operation at Republic Steel:

1. Technical operating training (pre-supervisory training).
2. Foreman training (present foremen only).
3. Machinist and electrical apprentice training.
4. Draftsman training.

Presented before AISE Pittsburgh District Section Meeting, November 8, 1948

TECHNICAL OPERATING TRAINING PROGRAM

The operation of our technical operating training program illustrates rather effectively the point of view in training to which Republic Steel has committed itself. This program is also likely to result in a significant contribution to industrial training.

Technical operating training, generally called T.O.T., is a two-year, pre-supervisory training program. It is carried out on-the-job in Republic plants under the immediate direction of the department heads and their staff. It consists of on-the-job training, lectures, visits to other related departments, and prescribed reference reading.

Extreme care is exercised in working out the right job assignment for each trainee, and in selecting a qualified candidate to fill each available training opportunity. This program is open to college graduates, present employees, and other applicants who meet T.O.T. requirements.

New groups are started approximately each six months in Republic's seven steel districts and is now being started in some of its manufacturing divisions. The technical operating training program is co-ordinated and directed in the district by the assistant manager. Quotas are set for each district. The number varies according to the size of the operations. In some plants there are only six trainees, while in others, as many as twenty-six. One or two trainees are placed in each operating department and in the maintenance departments.

Each trainee is under the direct guidance of the head of the department to which he is assigned. The trainee receives individual counseling and guidance from his department head and the district coordinator of the program. His progress is measured by periodic examinations and weekly work experience reports.

During the two-year training course, all of the trainee's time, except that spent in lectures and in

visiting other departments, is devoted to on-the-job training in the department for which he was selected. Thus, the trainee has an opportunity to learn first hand about the many jobs in his department. He lives daily with steel making and processing. He learns from actual experience the many phases of steel making and processing, such as operation of various types of equipment, standard practices and requirements, various policies and procedures; and he learns these things from personal observation, personal contacts, and experience on the job.

Twice a week the trainee leaves his department for the scheduled lecture session, or for a planned visit to another department. Lectures and visits are given on a carefully prearranged basis.

Each trainee spends some time in the department preceding and immediately following the one to which he has been regularly assigned in order to familiarize himself with related operations. He also spends time in learning the functions of the service and maintenance departments.

The training is regularly done on the day turn. Trainees work eight hours per day, five days per week throughout the full two years. During the two-year training period, the T.O.T. trainee is paid a salary which is increased every six months provided he makes satisfactory progress. Trainees are entitled to vacations on the same basis as other salaried employees. Upon completion of the T.O.T. program, he will be assigned to a beginning foreman's job in his own department at a rate no less than the final training pay.

SELECTION AND PLACEMENT IN DEPARTMENTS

Candidates who have expressed a desire to be considered for the T.O.T. program are first interviewed by a plant T.O.T. committee headed by the assistant district manager. Background information is reviewed at that time, and those who seem qualified are encouraged to fill out a "Request for Consideration" form and are then scheduled for vocational testing.

Candidates being seriously considered are given a battery of vocational tests which cover the following areas:

Mental alertness	Thoroughness
Mechanical sense	Initiative
Ingenuity	Tenacity
Imagination	Ability to express himself
Judgment	Ability to get cooperation
Organizational ability	Ability to deal with people
Cost mindedness	

Also, each candidate fills out a "Comprehensive Information Blank" and is interviewed by the corporation vocational counselor. The counselor prepares a vocational appraisal summary and submits it to the district T.O.T. committee.

The district T.O.T. committee and department heads who will have trainees working under them carefully review all information concerning each candidate and determine those best qualified for each department. In making these determinations the committee takes the following into consideration:

1. Vocational qualifications for the department.
2. Candidate's preference of department.
3. Appraisal and recommendation of each departmental superintendent.

The candidate's wishes are considered together with the superintendent's preferences. When these personal factors are combined with the thorough background of vocational counseling and tests, a highly successful basis for selection and placement is made possible. So far there has been practically no loss of trainees due to dissatisfaction or failure to achieve what has been expected of them.

Candidates for T.O.T. training are given final review and approval by the central committee at Cleveland.

OUTSTANDING FEATURES OF REPUBLIC'S T.O.T. PROGRAM

1. Careful pre-selection and placement.

   Qualifications of each candidate are carefully appraised by a vocational counselor to make certain than he qualifies vocationally for supervisory work.

   The individual is assured before starting the training program that he is preparing himself for the type of work for which he is best qualified and in which he will have the best opportunity of progressing and suceeding.
2. Maximum time for training.

   All of the two-year period is spent in training, none of it to orient the trainee in order to find out what kind of work he might want to do. An individual who is uncertain or does not qualify vocationally is not selected and placed in the training program.
3. Goal is supervisory job.

   Only a limited number of trainees are selected for each plant — less than the number involved in the normal turnover of supervisors.

   During the last six months of training, each trainee is pointed toward a supervisory job in the department in which he received his training. Thus, he is provided with a systematic means of bridging the gap between his academic training and his first supervisory job in industry.
4. A voice in choosing the department.

   Insofar as possible, the selection of the department in which the trainee will be trained is a mutual affair between himself and the superintendent of the department. Thus, the trainee knows the objective for which he is being trained, the department in which he will be placed, and the person who will provide him with direction and guidance while in training and after he completes his training.
5. Carefully planned job experience.

   His on-the-job training is carefully planned before he undertakes the program, and the emphasis is placed on maximum of learning and not merely "spending so much time" in each department. The program and the training is carefully planned, developed, and followed-up.
6. Training by practical men,

   The entire training program, including the lectures, is carried out by the executives, managers, and department heads best qualified to share their experience of steel plant operation with the T.O.T. trainees. We, therefore, feel that the program is practical, interesting, and up to date.

Scrap

. . . . proper scrap preparation is one of the keys to increased ingot production . . . .

Figure 1 — The interior of the car illustrates the contents and the various types and sizes of scrap. Loading charging boxes with this type of scrap creates many problems.

Figure 2 — Close-up view of the pile to illustrate the bulkiness of the scrap.

Figure 3 — One of the first attempts at bundling loose plant scrap in which scrap was bundled and banded. The bundles were too heavy and the bands scrapped.

▲ "SCRAP PREPARATION" is one that is of vital interest because of the possibilities of increasing the tonnage of ingot steel through proper scrap preparation. It should be realized by the steel industry throughout our nation that the proper preparation of scrap is one of the most important factors in the production of ingot steel.

The demand for increased ingot tonnage is rapidly accelerating to a point far above our present furnace output. Many items are being tried out and new ideas are grasped with eagerness. A huge field remains to be developed with our present equipment.

To economically run an open hearth, the maximum efficiency must be obtained from all available equipment. The production capacity of an open hearth hinges around many intangibles. The first place to exhort additional efforts, I believe, is in the stock preparation division. It is only logical, therefore, to expect added tonnage when charging delays are eliminated or minimized.

The prevailing shortage of steel is caused by the *shortage of scrap*, the *inadequate method of charging* and the *improper preparation* of available scrap. Scrap should be baled or bundled, and all unprepared heavy melt should be cut small enough to give plenty of weight in a buggy. This method of preparing scrap results in increased weight per buggy thereby reducing the number of buggies per heat and decreasing the charging time.

Long, slow charging due to light, loose scrap definitely influences the total heat time and, at the same time, hampers the charging of other empty furnaces.

The first and most logical place to gain that much desired tonnage reverts back to charging. A well-balanced charge is a prime factor to be considered. Although considerable time may be gained from heat to heat, this gain may easily be lost with slow, bulky charging. Delays while melting down cause foamy heats and, in some cases, minor refractory repairs when brickwork has been pushed out.

Various shops in the country are going to larger doors and larger charging boxes. There is, however, a limitation to the size of the box to be used. After two or three drags are charged into a furnace, if the boxes are too large and scrap is piled too high in the furnace, it is almost impossible for a charger to turn or dump these boxes in a furnace. Also, shops built in the past have not taken into consideration the necessity of allowing

Presented before AISE Detroit District Section Meeting, November 9, 1948

Preparation

By R. F. FIEN
Ford Motor Co.
Dearborn, Mich.

more space between each furnace. This would permit greater flexibility in charging the furnaces, especially when several adjacent furnaces are charging at the same time. This was evidently caused by the shops having been designed for smaller furnaces or hearth areas. Now due to the increased hearth areas or larger furnaces being constructed in the same shop, much of the valuable space between furnaces has been used up.

Scrap in our case is like that in most other plants, inasmuch as it emanates from two sources, home and purchased. We have our problems with both types of scrap. While we are able to control more closely the contaminated scrap that is produced in our plants, we face the bundling problem. Where it is possible, we make every effort to bale our own back scrap.

Scrap is segregated into piles of the various classifications in the yard, i.e., railroad heavy melt, heavy melt, bales, turnings, bushling, light scrap, etc. Select cars of inbound scrap are analyzed as they reach the plant and are piled according to analysis and classification. Our yard capacity is approximately 65,000 tons. At present we are not piling alloy scrap. Our scrap loading into boxes takes place in the open hearth and is rather unique. A reserve bank of scrap is maintained in the open hearth stockhouse bins for emergencies. We have a capacity of 250,000 lb of heavy melt, 400,000 lb of bales, 200,000 lb turnings and 100,000 lb of miscellaneous agricultural and auto scrap. In case of a breakdown or failure of any nature, we could get by for an 8-hour period with this reserve.

Some of our charging box capacities have been increased from 22 cu ft to 51 cu ft during the past year. Scrap comes in on a spur adjacent to the charging floor on a track that has a capacity of 12 gondolas of scrap. It is brought to the floor with three 10-ton stock cranes, using 65 in. magnets.

Due to inadequate space on our loading floor in the stockhouse, it is impossible to employ trimmers to trim the boxes while being loaded with the magnet.

Two diesel-electric locomotives switch the buggies to the scale for weighing and to and from the furnaces.

Prior to preparing the scrap in bundles and distributing the heavy and light scrap, it was necessary to switch the scrap cars in and out every four hours. This switching has been cut 100 per cent by a more uniform distribution of scrap and the track is now switched every 8 hours.

Billets, bars, cobbles, pipes, skulls, etc., are torch cut in the scrap preparation area outside of the open hearth. Molds are broken with a 5-ton ball to charging box size.

Figure 4 — The second attempt at bundling was successful due to minimizing the bundle size. These bundles were easily handled with stock cranes.

Figure 5 — A view of light unprepared scrap prior to being sent to the charging floor. Although large charging boxes were used, the total box weight was still too light to accomplish fast charging.

Figure 6 — This condition is what might be expected when only light, loose scrap is available for charging. The scrap is bulky, falls on the floor, hampering speedy charging of the furnace and adjacent furnaces, and causes cars to be derailed, etc.

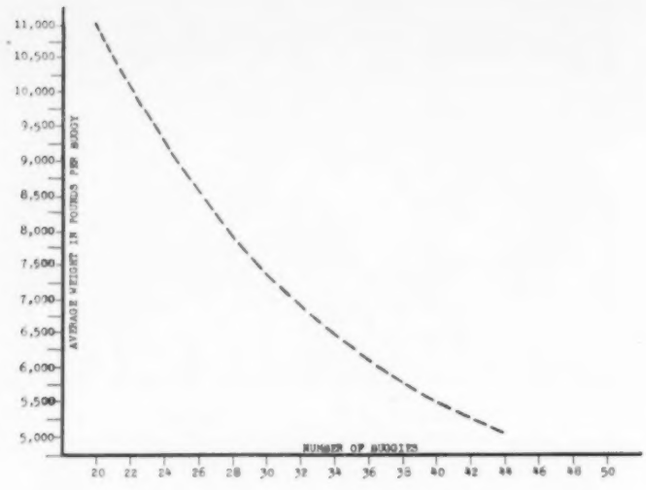


Figure 7 — The graph illustrates the relation of number of buggies to the weight per buggy. As the weight increases, the buggies required decreases.

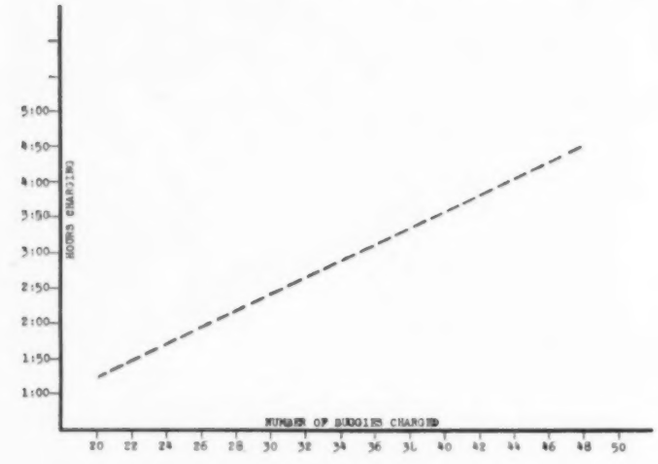
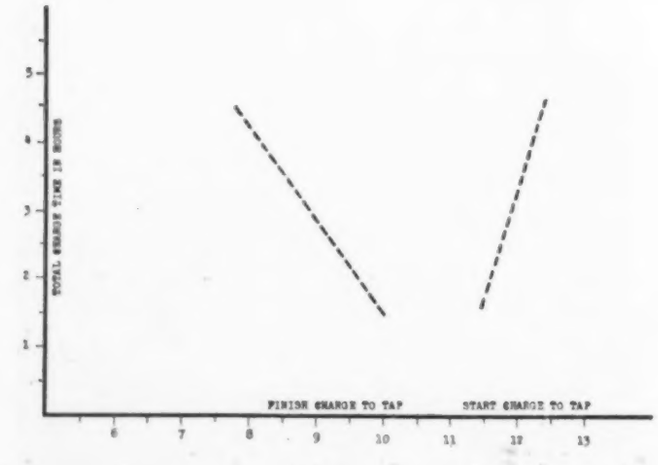


Figure 8 — In this graph the average number of buggies charged were plotted against the total time required to charge the furnace. There is a definite increase in the hours required to charge as the buggies are increased.

Figure 9 — As the charging cycle increases, so does the total heat cycle.



Much progress has been made in the last year in reducing the number of buggies or boxes required to charge a heat. A year ago, one buggy of limestone, or four small boxes, amounted to 6200 lb. Stone is now charged in three large boxes, or one buggy and contains 13,000 lb.

Switch orders are lined up by one man who works in conjunction with the car placers. Every car of scrap that is charged is inspected by this man. He works closely with the scheduling division to learn of our requirements for the coming 24 hours. The switches are then lined up to properly allocate the scrap for uniform density, and controlling of possible contamination to prevent them from reaching heats that are to be melted for deep drawing purposes.

Cars that are contaminated with copper, nickel, molybdenum and tin are earmarked and distributed over less critical heats where higher residuals are permissible.

In our shop we are not equipped at the present time for making flush heats on all furnaces. It is, however, our aim to have all furnaces equipped with the facilities to make these heats. We have already realized a 20 per cent reduction in our scrap where flush heats are made, although we now are only able to use about 50 per cent of our furnaces for flushing. When furnaces are grouped to charge together, much time can be saved and many delays can be eliminated by working in a flush heat.

At present we have a new skull cracker building under construction, and have large expectations planned when it will be in operation. Steel buttons, skulls, molds, etc., will all be handled at this point and segregated from the other scrap piles for distribution.

We are also extending the south end of our open hearth to expedite the handling of hot metal in torpedo cars, and are building bins for work and feed ore and limestone. This will speed up our charging considerably and, as a result, increase our steel ingot output.

Our company is giving every consideration to provide proper facilities to be used in the preparation of scrap and are continually doing their utmost to provide better methods of shortening the time charging. The better the preparation of scrap, the faster it can be charged, the sooner it can be melted, the more rapidly it can be converted into ingot steel.

DISCUSSION

PRESENTED BY

ALAN F. DANZER, Viking Steel Co., Detroit, Mich.

R. F. FIEN, Ford Motor Co., Dearborn, Mich.

Alan F. Danzer: Mr. Fien suggested baling light scrap. I was wondering if any facilities were being made available for that type of operation in the Ford Motor Co.?

R. F. Fien: At present we have eight balers. We are baling most of our scrap, practically all that can possibly be baled. We also expect to get another one, or two.

A NEW TYPE SOAKING PIT INGOT BUGGY

. . . . through the use of a number of ingenious ideas in the design, the unusual ingot buggy described is operated through remote push-button control . . . .

By S. H. MUMMA
Assistant Superintendent, Electrical Department
Bethlehem Steel Co.
Steelton, Pa.

▲ THE ingot buggy described in this paper (as shown on Figure 1) is in service at the Steelton plant of the Bethlehem Steel Co., delivering ingots from the new soaking pits to the 44 in. blooming mill. It was designed to handle ingots 28 × 32 in. × 7 ft 0 in. long, weighing about 15,000 lb. The speed of the buggy is 600 fpm, the longest run is 300 feet. As the mill requires two to two and one-half minutes to roll an ingot, the buggy has plenty of time to make a round trip at this speed. Another requirement of the buggy is to deliver ingots, by automatic dumping either top or bottom first on the mill approach table.

The blooming mill is in a building, so located with respect to the pit building (as shown on Figure 2) which makes it impossible for the soaking pit cranes to carry ingots direct to the mill table, so the buggy must give very reliable service. Another problem is that the mill and pits are so located that the ingot must be discharged from the front of the buggy to the mill approach table, which makes the limit of travel of the buggy very critical.

The motor drive for the buggy is located in a concrete-enclosed room at the center of the run under the track. The motor-generator set and control panels for operating the buggy and the control panel for operating the mill approach table are located in a small building outside the pit building which is connected with the buggy drive room by an underground passageway.

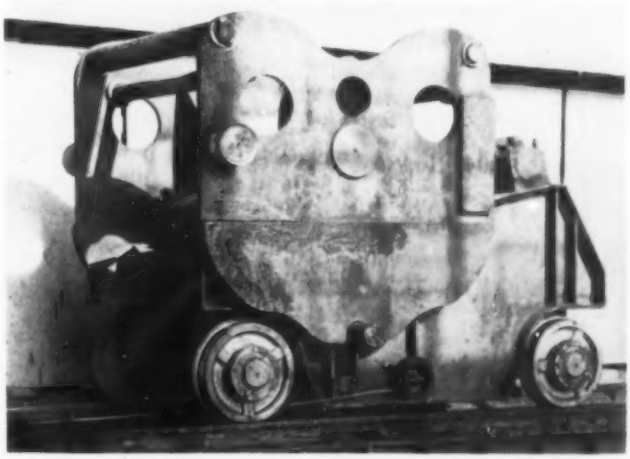
The buggy is controlled by the soaking pit crane operators from the crane cabs. The roller boss advises the craneman over a communication system, in the crane cab, which way the ingot is to be rolled, if it is to be rolled top first, the ingot is placed in the hopper leaning forward, if it is to be rolled bottom first the ingot is leaned toward the rear of the hopper. As the craneman also operates the pit covers from the crane cab, it is impossible for him to spend any time watching the travel of the buggy so it must be automatically controlled after being started toward the mill.

The buggy consists of three separate assemblies, the truck, the roller table and the hopper or cradle (shown on Figure 3). The truck is of welded construction, carried on four 24 in. single flanged wheels, fitted with roller bearings, which turn on fixed axles. The wheel base is 8 ft 0 in, the track width, standard railroad gage, 4 ft 8½ in. The buggy roll table is, also, of all-welded construction, and is supported on standard railroad car springs, which rest on the truck, over the axles. A pin through the center of the truck couples the roller table support to the truck. The roll table consists of three 12-in. diameter idler rollers on a 12-degree inclined plane, each roller mounted on a shaft which turns in bronze bearings. Two brackets on the roll table support carry the tilting hopper. A support is provided between the front and the second rollers to suit the bottom of the ingot.

The hopper consists of two heavy side plates, 2 in. thick, with four rods between them. It is supported by a short heavy trunnion at each side, which rests on the bearing brackets mounted on the roll table support and is counterweighted with additional 2 in. plates on the bottom. The hopper is held in the vertical position by a latch bar resting on springs, which fits in a notch at the bottom of both plates. This latch bar is released by the dumping cams at the mill approach table. A roller guide is located on each plate which, by engagement with the dumping cams, controls the rate of tilt of the hopper after the latch bar is released.

The buggy is provided with a cable attachment on the rear axle where both cables are fastened. It is also equipped with a hopper for collecting scale from the ingot, which is automatically dumped while the ingot is being dumped. The weight of the complete buggy

Figure 1 — The ingot buggy is cable operated and is essentially a horizontal elevator.



Presented before AISE Philadelphia District Section Meeting, March 5, 1949

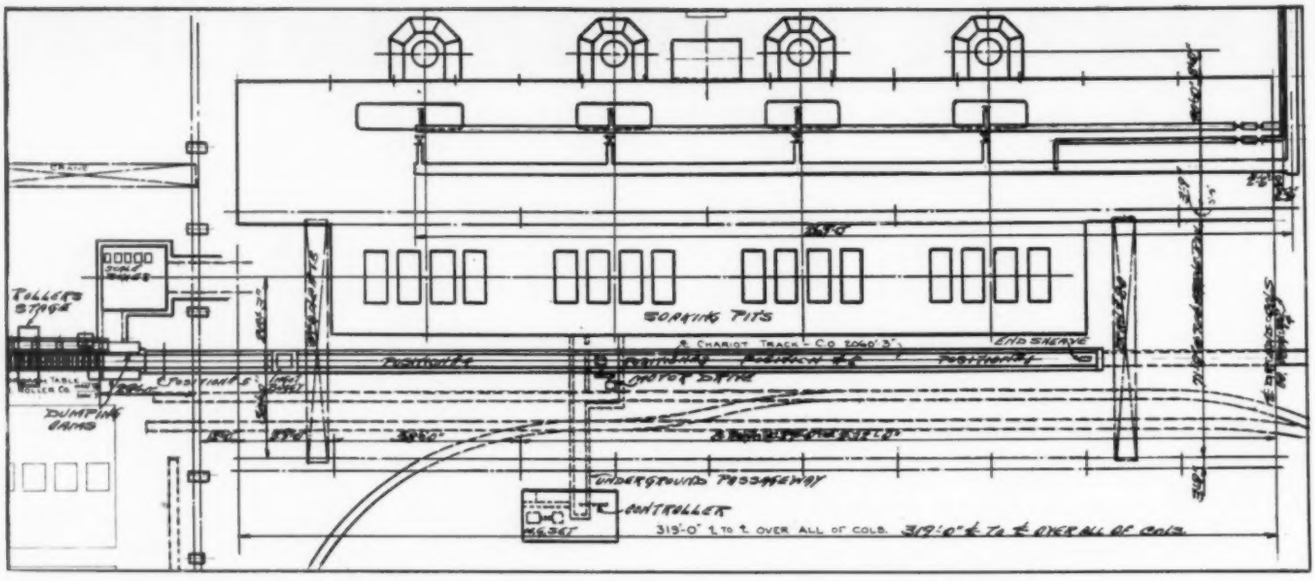
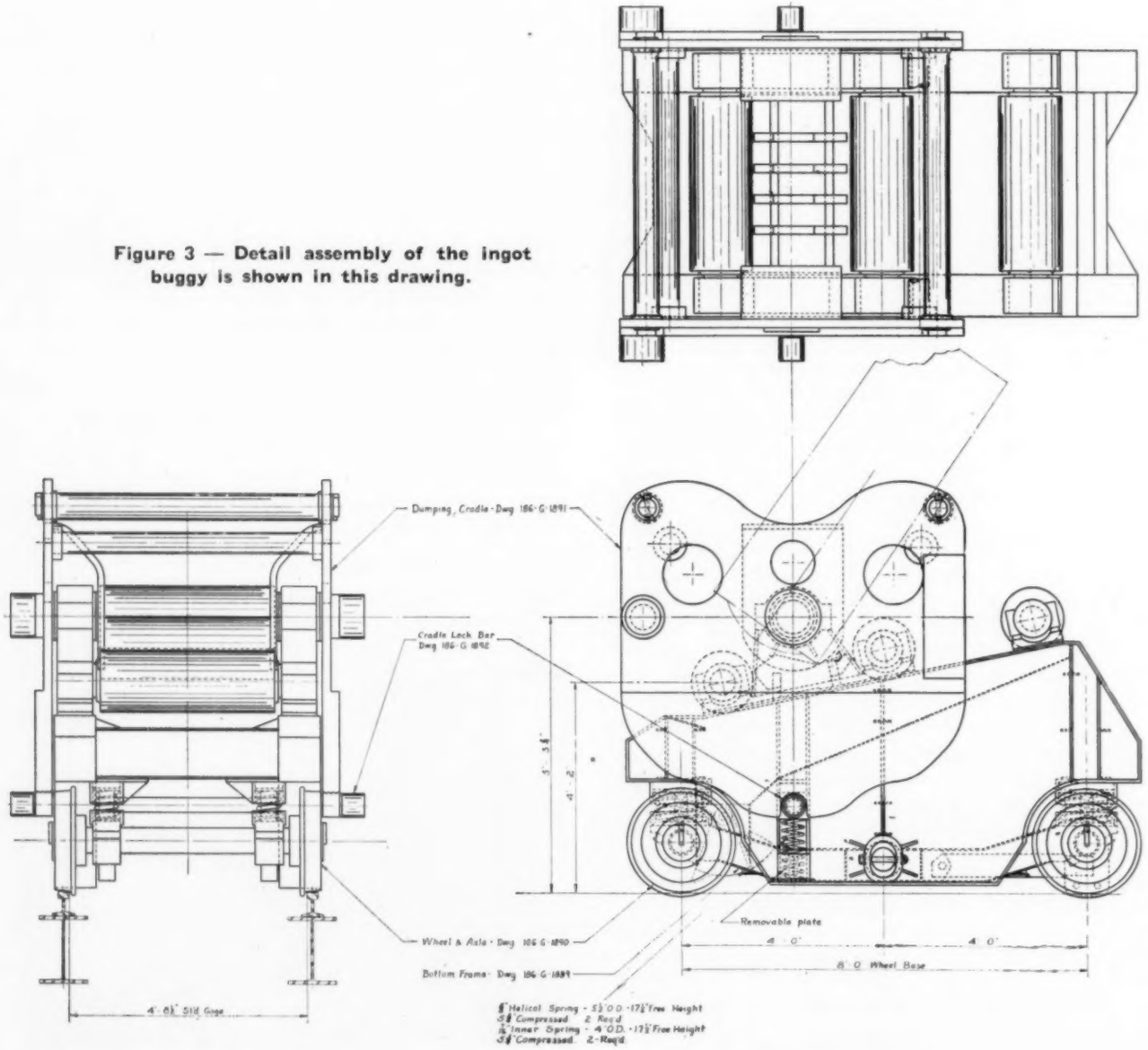


Figure 2 — The travel of the buggy is illustrated in this mill layout.

Figure 3 — Detail assembly of the ingot buggy is shown in this drawing.


Dumping Cradle - Dwg 186-G-1891
Cradle Lock Bar Dwg 186-G-1892
Wheel & Axle - Dwg 186-G-1890
Bottom Frame - Dwg 186-G-1889
Removable plate
4'-0"
4'-0"
8'-0" Wheel Base
4'-8½" Std Gage
5'-3⅝"
4'-2"
⅞" Helical Spring - 5½" O.D. - 17½" Free Height
5⅛" Compressed 2 Req'd
⅝" Inner Spring - 4" O.D. - 17½" Free Height
5⅛" Compressed 2 Req'd

(without ingot) is 18 tons. The buggy is drawn by cables, carried over a sheave at each end of the track, and back to a drum in the center of the run under the track. A concrete foundation at yard elevation carries two rows of 16-in. wide-flange I-beams on which are mounted 100-pound T-rails to make the track for the buggy. The 16-in. beams are required to raise the buggy to suit the mill approach table, they also provide a space between the concrete base and the buggy for both cables above ground, making them accessible for inspection and repairs (Figure 4).

The two cables for operating the buggy are $\frac{3}{4}$ in. diameter, 6 × 19 stranding, pre-stretched, each 475 ft long. One cable is attached to each end of the buggy then taken around the end sheave and back to the at the angle; the sheave is supported on the one leg; to the other is attached a 1200-lb counterweight. The sheave leg is 2 ft 0 in. long, the counterweight leg is 4 ft 0 in. long. This assembly is supported on a movable platform, which rests on the I-beams supporting the track rails. Two screws, 24 in. long, are provided at both ends of the track to move the platform supporting the sheave wheels, to tighten the cable. When a cable is put on the drive, it is made as short as possible, and as it stretches, the counterweights drop down, keeping the cable taut. This slack can be taken up by moving the end sheave platform with adjusting screws. There is 2 ft 0 in. take-up at each end. When the buggy is started, the cable will pull on the end sheave, lifting the counterweight up against the spring shock absorber

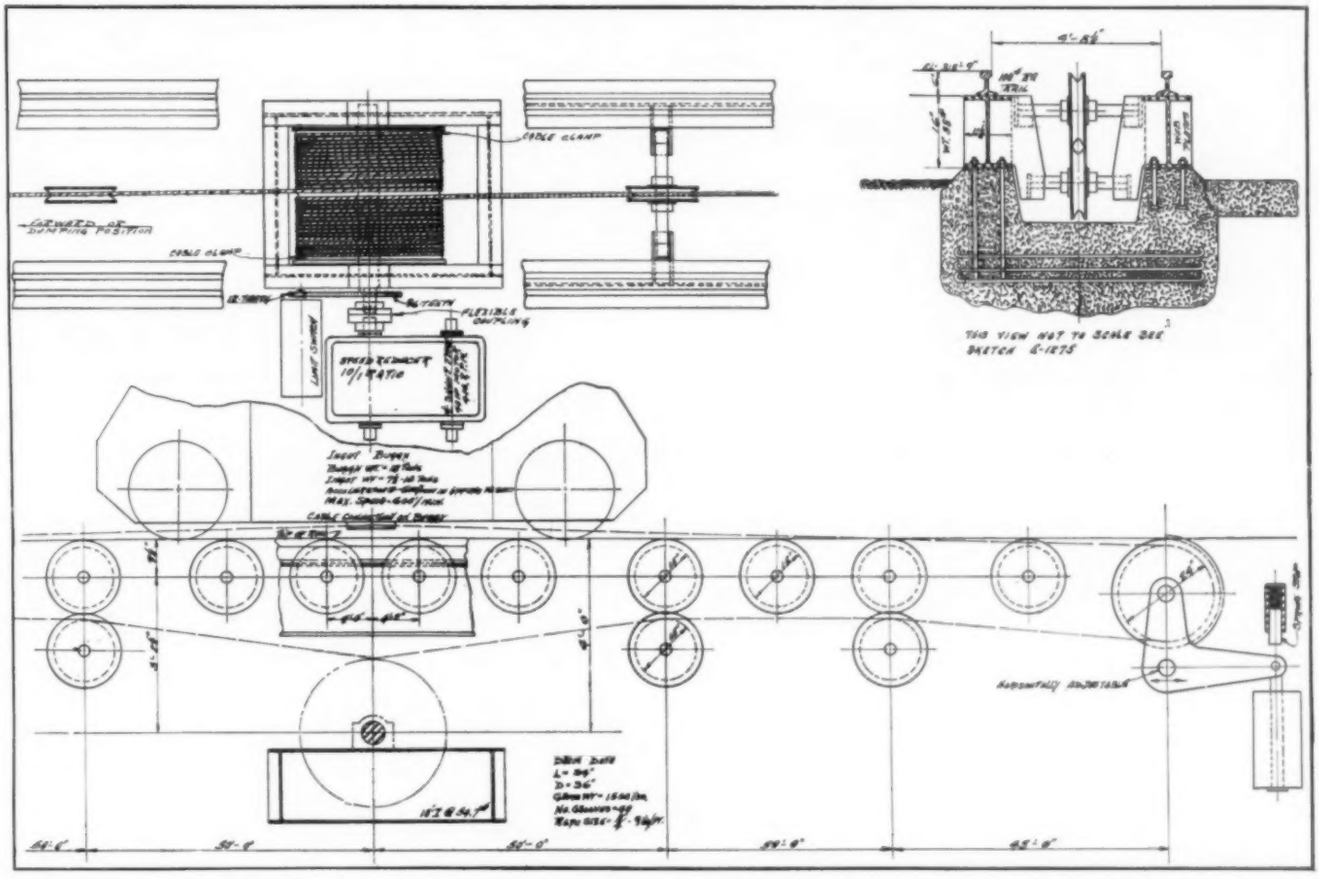


Figure 4 — It was essential in the design to make proper provisions for variations in the length of the cable.

drum. One cable is attached to each end of the drum. The drum is 3 ft-0 in. in diameter with one continuous groove, and wide enough for about 400 ft of cable, so that as one cable is wound on the drum, the other cable is unwound. The cables between the buggy and the end sheaves, and between the end sheaves and drum are carried on roller-bearing sheaves to prevent them from dragging on the concrete foundation. The cable drum and support are both of welded construction, all roller bearings. The drum is driven by a 20:1 speed reducer, through a flexible coupling, and the speed reducer is driven by a 40-hp motor through a flexible coupling.

The end sheaves, which also act as cable tighteners, are 24 in. in diameter, and are supported on movable arms (Figure 5). These arms are L-shaped with a pivot stop; the cable on the opposite end of the car will slack, and let the 1200 lb counterweight on this sheave drop down. When the car is stopped, the slack and pull are in the opposite directions. We allow about 6 in. slack at each end. The amount of counterweight is adjusted to give the smoothest operation.

At the dumping end of the travel, a dumping cam is erected on both sides of the track (Figure 6). This cam is built up of heavy angle sections, welded together, and supported on a concrete foundation on both sides of the track. It is held down by bolts imbedded in the concrete foundation. The guides are arranged to take the rollers on the buggy to dump in either direction, depending on whether the weight is forward or backward on the hopper, when the latch is released. As the buggy enters the tilting cam, the latch bar is released

by running under an angle releasing the hopper to dump, as governed by the weight of the ingot. The rollers follow the heavy angle guides in the two cams, tilting over until the ingot is laid on the rollers, and runs off on the approach table. The buggy runs up to the spring bumpers, and is stopped by the limit switch.

The approach table is made up of different size rollers to decrease the angle of the rollers on the buggy, which allows the ingot to discharge smoothly. As the buggy comes to a stop, a door at the bottom of the scale collector is automatically opened, and the scale is dumped into a chute which conducts it to a tote box under the buggy track. The front axle of the car strikes two highly damped spring bumpers if for any reason the buggy does not stop in time.

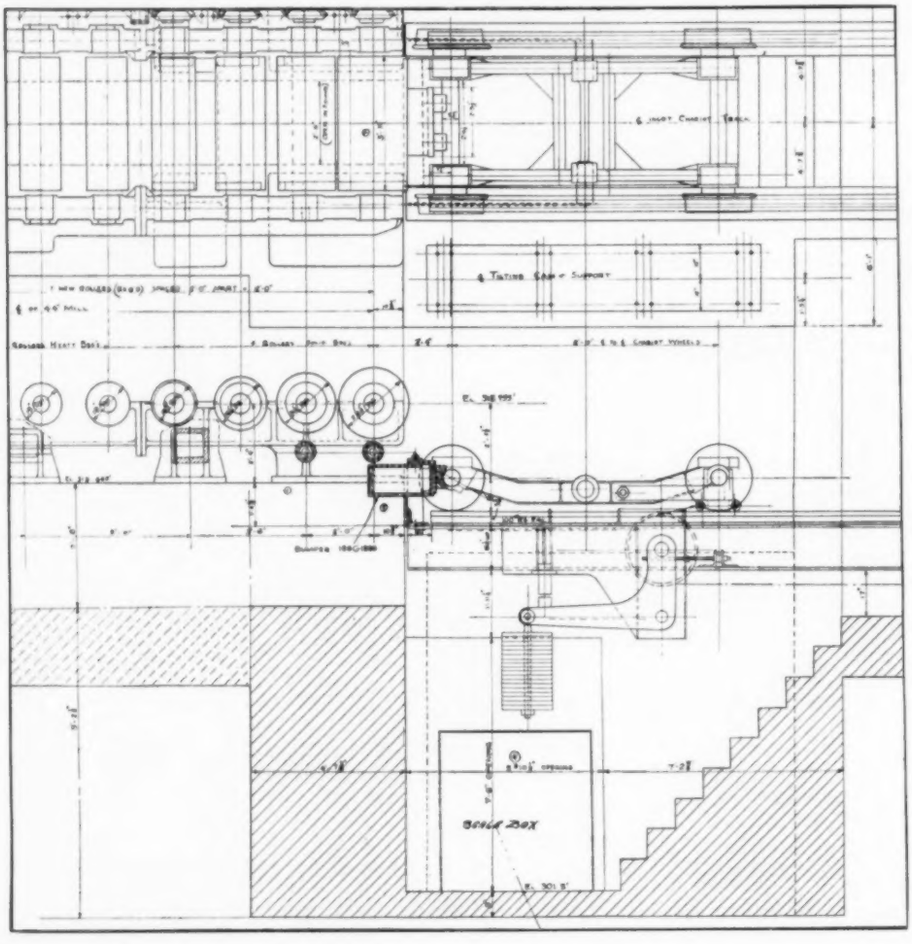


Figure 5 — Tightening of the cable is done by the design of the end sheaves.

ELECTRICAL EQUIPMENT

The operating motor which drives the cable drum is a 40-hp, variable speed, machine tool type motor, 400 to 1600-rpm, shunt wound, 230-v d-c, normally running at 700 rpm. It is operated by a variable voltage control. The motor-generator set consists of a 30-kw generator, and a separate exciter, driven by a 440-v, 3-phase, 25-cycle induction motor. The control panel consists of a main-line contactor, a dynamic braking contactor, reversing field contactors, and the necessary protective and control relays. The acceleration and deceleration is controlled by six steps of variable voltage on the generator, and two field weakening steps on the motor, which are timed by a neon-tube timer. It requires 10 seconds to accelerate from 0 to 700 rpm motor speed, and about the same time to decelerate. A shunt wound brake is attached to the motor shaft. A set of push buttons, "Forward-Reverse-Stop" are located in each crane cage, and a set in the roller's stage. Since the crane operators cannot see the approach table from the crane cages, the control is arranged so that the cranemen control the buggy forward to position No. 5, which is at the mill end of the soaking pit building, and reverse from this same position. From position No. 5 to the rolls, and back to position No. 5, the buggy is under the control of the roller. Transfer switches are located in both crane cages, so that only one crane operator can control the buggy at a time. If both cranemen close their switches, the control circuit to buggy is out of service. A red light on the side of the crane cage shows which control switch is closed. The buggy will automatically return to the block of pits where the crane, which is controlling it, is located. To operate this control, a traveling nut type limit switch is directly connected to the drum drive. This limit switch consists of fourteen switch units, which are located along the screw to give the desired sequence of operations. Starting at the far end of the travel there are two slow-downs, and a final limit, next four stops at the four blocks of pits, then two slow-downs and a stop at position No. 5, which is at the end of the craneman's control; the next unit starts the mill table rolls as the buggy approaches the final limit; at the end of the travel, there are two final limits. To carry this control to the cranes, four

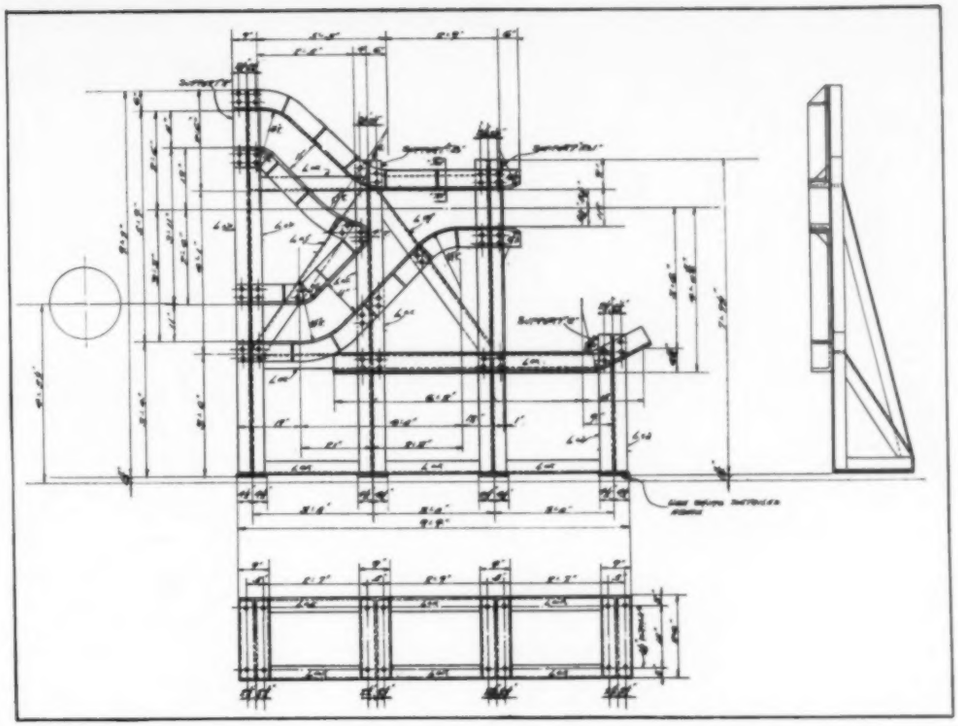


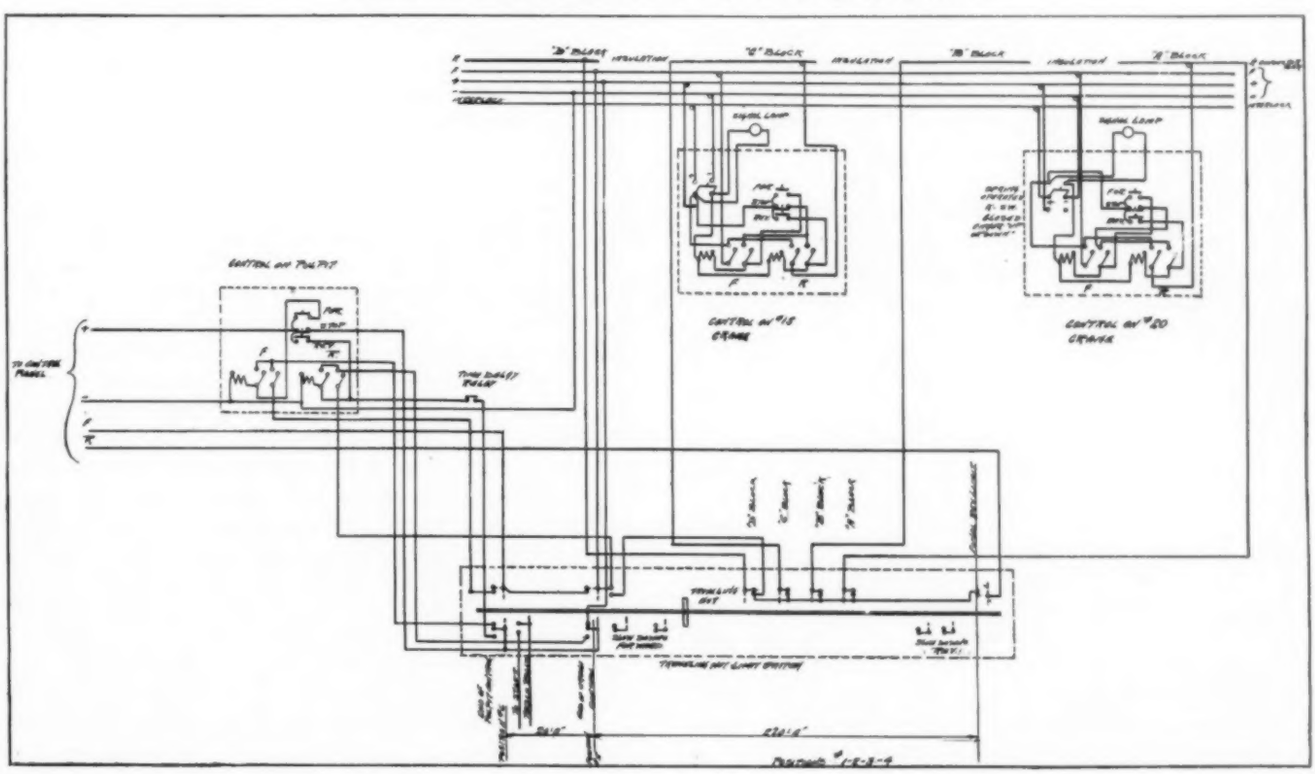
Figure 6 — The dumping cams are made up of angle sections.

trolley wires and a sectionalized conductor bar are used. A small contactor panel is also required in each crane cage, and one in the roller's stage to set up the control circuit.

THE OPERATION OF THE BUGGY

The operation of the buggy is as follows: The crane man who is drawing ingots closes his switch on the buggy control, this lights a red light on the outside of the cage, showing the other craneman that he has control of the buggy. He then opens the pit cover from the crane, draws an ingot, closes the pit cover, and places the ingot in the buggy, tilted for the proper discharge. He has been previously instructed by the roller boss, over the communication system in the crane cage which way the ingot is to be rolled. After the ingot is placed in the buggy, he presses the "Forward" button,

Figure 7 — Wiring diagram of control and limit switch.



and as the buggy starts he is finished with that operation. The buggy accelerates automatically and runs to position No. 5, slows down and stops. The craneman, however, can stop or reverse the buggy at any time during this forward trip if it is necessary. When the buggy reaches position No. 5, it comes under the control of the roller. When the roller is ready for the ingot, he presses the "Forward" button on the stage; the buggy starts forward slowly as the run is only 15 ft; the voltage is held to 100 volts. Soon after the buggy leaves No. 5 position, a switch on the traveling nut limit switch is closed which starts the mill approach table rolls; the buggy then enters the dumping mechanism which releases the latch on buggy, and the hopper tilts discharging the ingot on the roller, which conveys it to the approach table. The buggy is stopped by the final limits on the traveling nut limit switch as it reaches the end of the travel. As the ingot is carried away on the mill approach table, it operates a gate in the table which actuates a limit switch reversing the ingot buggy. As the buggy travels back to position No. 5, it opens the switch unit of the traveling nut limit switch, stopping the mill approach table. The buggy is then stopped at position No. 5 by the traveling nut limit switch; the control of the buggy is now returned to the craneman. The roller, after he presses the "Forward" button to discharge the ingot on the approach table, does not pay any attention to the operation of the buggy, although he has a "Stop" and "Reverse" button which he can use at any time. The "Stop" buttons will stop the buggy any place in the mill in an emergency.

The buggy is now in position No. 5 and ready to return to the position of the crane which is controlling it. The craneman now presses his "Reverse" button, the buggy starts, accelerates, and stops at the block of pits where the crane which is operating it is located. If the craneman moves to another row of pits, farther away from the mill, the buggy will follow after him. He can always inch the buggy forward, but to move it in reverse, he must move to the next row of pits farther away from the rolls. The shunt brake on the drive motor operates only at the final limit in the "Forward" position; the other stops need not be so accurate. The brake will operate anywhere in case of a power failure. The buggy has now been in operation almost two years, and has given very satisfactory service. The cables last at least a year.

The control has given very little trouble; about the only extra attention required is the setting of the final limit at the mill end of the travel. We have the electrician on each turn check this setting, and amount of slack in the cables. The feature of collecting scale and dumping it at the end of each trip works out fine, and keeps the track and pit building clean. The boxes of scale are handled by a lift truck in the pit cellar to where it is dumped in a car with the crane.

The power required by the buggy is about 35 hp to accelerate and 8 to 10 hp after it is up to speed.

Since no separate operator is required to control the buggy, it permits a considerable saving in the mill operating costs. Another labor saving feature is the collection and dumping of scale which saves the labor of cleaning up along the track the entire length of the pit building.

DISCUSSION

PRESENTED BY

JOHN C. REED, Retired, Steelton, Pa.

S. H. MUMMA, Assistant Superintendent, Electrical Department, Bethlehem Steel Co., Steelton, Pa.

John C. Reed: Since I happen to be the inventor of this ingot "buggy," it gives me great pleasure to discuss it. When word was received that we were going to build a new soaking pit building with all the auxiliaries that go with it, I started to make a study of the handling of the ingots from the time they left the open hearth until they were on the rolling mill table, giving thought to how many manhours I could eliminate if I could accomplish certain things. First, I would need to deliver the ingots into the mill, standing vertically on their stools on the trucks with all stools loose from the ingots. Second, I would need to do a good job of air-conditioning the crane cages. Third, I would have to find an ingot "buggy" which would receive an ingot in a nearly vertical position and deliver it to the mill, either bottom first or top first as may be desired and which could be operated automatically by simply pushing a button either in the crane cage or rolling mill pulpit or both. Fourth, I would have to persuade the cranemen to operate the devices necessary to open and close the pit covers and operate the ingot buggy.

My experience in dealing with shop stewards led me to believe that I would not be able to get a craneman to do something that he had not been doing before unless I had something to trade with, so if I could accomplish my first objective, the fourth one would be automatically solved.

I think I had more grievances regarding ingot stools sticking to the ingots than anything else. Those of you who are connected with the steel business know that it is not always possible for the open hearth to make steel in such a way as to avoid having some ingots burn fast to the stools, and the stools have to be knocked loose in some manner before charging the ingots into the pits. This requires extra handling on the part of the soaking pit cranemen and also delays the charging of the ingots, causing them to cool so that they are harder to handle and more likely to be dropped.

I could not find any bottom knocker, as we call it, which could be operated from the stripper crane without having extra men on the ground; but after giving the matter some study, I was able to devise a bottom knocker which can be entirely operated by the stripper cranemen and which loosens the stools right on the trucks without lifting the ingots from the trucks. I will not take time to describe this device.

The second objective which I would need to achieve in order to reduce the manhours about one hundred hours out of every twenty-four hours operation was effectively to air-condition the crane cages.

Now, this air-conditioning problem is not always the easiest thing in the world to do, and to air-condition a

crane cage which is required to operate right over the top of a soaking pit, is asking a lot. So, after considerable study, we decided that we could operate these cranes with the cages on the bridge. As Mr. Mumma has told you, this has worked out very well, and has given us a number of advantages. This location enabled us to remove all of the controllers from the trolley and also enabled us to get the control circuit wires into the cages without having to add a lot more trolley wires on the crane. It also gave us ample room for the air-conditioning equipment.

The third requirement was to find an ingot buggy which could be operated automatically. We sent out inquiries for ingot buggies and we received propositions from all the builders, but I did not find any which I felt could be operated automatically. Mr. Mumma told you that he uses 14 switches in the screw type limit switch. With a traction drive, that is, with a motor on the machine, you would have to have 14 track switches.

I have had a lot of experience in this business, and that experience taught me that a track switch is not the most reliable piece of apparatus with which we sometimes have to work. In the first place, it is all closed up in a box, and you cannot see the thing function, and if it fails it does not always fail "safe," and that is a prerequisite in the operation of a drive of this nature.

I decided we would have to use something different from 14 track limit switches, and it was to get a reliable limit device or control device more than any other thing that led me towards the cable drive.

Now, some people think the cable drive is no good. Why, I do not know. We use cables very extensively on our cranes. We use them on skip hoists, and we have thousands of elevators running all over this country using cables. So, if that is true, it seemed to me there is something wrong, if we could not design a cable drive to pull the buggy back and forth on the horizontal. What we had was virtually an automatic elevator, a six-station automatic elevator, except that it would work on the horizontal instead of on the vertical.

Now, one of the reasons that that kind of drive has not worked, or that people are prejudiced against them, goes back a long time. In the early part of the century, we used a lot of cable drives in the mills that were operated with little steam engines. In fact, we used steam engines on the roller tables, and the first move towards electrification in the steel industry was to take off the engines, and put on a street car motor, with a street car control. It is needless to say it was impossible to keep from having smash-ups with that kind of equipment.

With the apparatus you have today, the automatic control, especially the variable voltage control, and a shunt motor on your drum drive, you can make a cable drive do just about anything you want it to do.

There are a lot of things about a cable that people do not generally understand. There were a whole lot of things I did not understand even if I had 45 years of experience in handling them. So I went up to Williamsport and talked to our cable engineers, and I think I learned more about cables in about 45 minutes than I had previously learned in 45 years. Among the things I learned was this, I suspected this before, but I had to substantiate it this time, that when you put tension on a cable, it stretches, and that stretch is divided into two kinds of stretch. There is what we call the structural stretch and what we call the elastic stretch.

Now, the structural stretch is that stretch which occurs in a cable due to the tightening up of the wires in the strands and the strands in the cable. That reduces the diameter of the cable and increases the "lay" and lengthens the cable. Mr. Mumma mentioned the fact that we were using pre-stretched cables. Well, I learned another thing, that the pre-stretched cable takes out only about 25 per cent of the structural stretch. The rest has to come out after you put it to work. When it is working and running over the sheaves, the wires and strands are kneaded into position causing the permanent stretch in the cable.

So, in designing this cable drive, we had to make provision for taking up the structural stretch. This 475-ft cable will stretch about 10 ft from the time you put it to work until you have taken it all out, which means that you have to make provision for taking up that stretch in an easy manner, from day to day, until you get it all out. We put those sheaves on the end of the runway, and mounted them in such a manner that the stretch could be taken up, all as has been described by Mr. Mumma.

Now, in addition to the structural stretch, you have the elastic stretch. The elastic stretch is due to the stretch of the steel, the same as in any piece of steel and it is figured by the well known formula.

$$\text{Elongation in inches} = \frac{\text{Pull in lb} \times \text{length in in.}}{\text{Area in sq in} \times 17{,}250{,}000}$$

The figure 17,250,000 is the modulus of elasticity. The area is the sum of the area of all of the wires composing the cable. We have a pull on the cable of 1200 lb due to the weights, and an additional pull of 1800 lb during acceleration, so when nearly all the cable is off the drum, the cable lengthens about 3 in. due to the elastic stretch. This together with the slack in the drag cable due to the compression of the bell crank stop spring on the pull cable, and decreased length of the pull cable between the sheaves due to the decreased sag in the catenary, all add up to between five and six inches, so that during the accelerating period the surface of the drum has moved this much more than the buggy has moved, and the bell crank on the drag cable has to take care of this extra cable. See Figures 4 and 5.

Mr. Mumma called attention to the fact that we have weights suspended on the horizontal arm of a bell crank and the end sheave on the vertical arm. These bell cranks are there to take care of the elastic stretch of the cable. In addition to the elastic stretch of the cable, there is always a small amount of spring action, so it is necessary always to have a cable under a certain amount of tension to get good operating results.

When we sent out inquiries and received the propositions on the buggy, there was only one which I felt could be made to work automatically. This consisted of a flat car having mounted thereon a horizontal roller table of nine or ten rolls driven by a motor through a line shaft and bevel gears in the conventional manner. Over the center of this table was placed a receptacle which I will refer to as a cradle to receive the ingot in a vertical position. This cradle was arranged so it could rotate 90 degrees either forward or backward by means

of a motor through a worm gear reducer. The cradle did not have a bottom in it, so if it was lowered backwards, the ingot would go into the mill through the cradle, bottom first, and if it was lowered forward, it would go into the mill top first. Mechanically, this was all very simple, but the electrical features were appalling. To begin with, it would require four conductor bars the length of the mill, and fourteen track switches to take care of the travel. It would then require eight main contact devices at the mill end and eight auxiliary contact devices to control the lowering and raising of the cradle and, of course, there would be three controllers required. I did not feel that this equipment could be maintained in a satisfactory operating condition.

When I started to think what would be required in the way of a controller to operate the cradle, I soon discovered that except for the first 10 degrees of rotation, no power would be required since gravity would do the job the rest of the way, and I would be only concerned with keeping it from lowering too fast. The thought came to me that if instead of making the sides vertical, I sloped them, I could set the ingot in the cradle at a slant, and the direction in which I set it would determine whether it would enter the mill, bottom first or top first. It then remained only to provide a spring operated latch to hold up the cradle and cams at the mill end to control the lowering, all as has been described by Mr. Mumma.

The next thought that came to me was that since the ingot was always going to move off the table in one direction, why not use idle rollers and incline the table and let it roll off by gravity. So I used gravity to lower the ingot and roll it off the buggy and got rid of two motors and all the auxiliary electrical equipment that went with them. Having used gravity to lay down the ingot and roll it off the table, I toyed with the idea of taking it up to the mill on an inclined track by gravity, but had to discard the idea due to certain requirements of the rolling mill superintendent which I was unable to meet with such an arrangement, so I used the cable drive principally because I needed a limit or program switch which I felt could be depended on 100 per cent. So I used the screw type limit switch. A cam type limit switch would work just as well but I like the screw type switch since the traveling nut, which actuates the control switches, reproduces in miniature the travel of the buggy and you can stand over it and see everything function, and if inspected frequently, it can always be kept in perfect working order.

I want at this time to give credit to Mr. Francis Weiss who made the drawings for this buggy, for making certain discoveries. During the process of its design, we found that instead of placing the ingot over the top of a roll, if we placed it between the rolls and gave it more slant, it would operate much better. Also by moving the cradle up to the front of the car, it is possible when rolling ingots top first to lay the ingot directly on the receiving table, and reduce the number of rollers from nine or ten to three. We made a number of working models of the buggy during the development, to see how it would work, and I had rather hoped the final one would have been brought down for your inspection.

Mr. Smiley made reference to the lightness of this buggy, but I assure you this is only relative. If I had placed the drive motor on the buggy, it would have been at least 60 per cent heavier. When you consider that the buggy is only about 11 ft long and about 5 ft wide, not any larger than a passenger automobile, and that it weighs 18 tons, it is a pretty chunky piece of equipment. A 50-ton capacity, 40 ft gondola freight car has about the same weight.

This is the only buggy of its type ever built and Mr. Mumma has stated it works very well; it is capable of being improved and I have in mind certain improvements to correct such defects as have shown up since this buggy has been put into service.

PLAN TO ATTEND!

The Annual Spring Conference

OF THE

ASSOCIATION OF IRON AND STEEL ENGINEERS

TUTWILER HOTEL **BIRMINGHAM, ALABAMA**

APRIL 3 *and* 4, 1950

MODERNIZATION OF THE STEELTON BLOOMING MILL

. . . . much of the unpublicized expansion taking place in the steel industry is the result of equipment modernization such as that described in this paper . . . .

By RUSSELL M. WEIGLE
Assistant Superintendent of Rolling Mills
Bethlehem Steel Co.
Steelton, Pa.

▲ BETHLEHEM Steel Co. has recently made a number of extensive changes in the 44 in. blooming mill at the Steelton, Pa., plant. These changes have improved the quality of ingot heating, increased production and lowered the operating costs.

The Steelton plant was one of the pioneer rail-rolling mills in the United States. The present 44-in., two-high blooming mill was built in 1913 and was originally driven by a steam engine. This mill was also served by twenty-six regenerative type soaking pits having a total capacity of one thousand tons of ingots.

In 1921, the steam engine was replaced by an electrical drive which is now in use. The motor is a double-armature, 5800-hp, 40 to 120-rpm, direct-current motor. Power for the motor is supplied from a flywheel motor-generator set made up to two direct-current generators and a wound-rotor induction driving motor. The primary power input is limited by means of an automatic liquid slip regulator. When this drive was installed, the motor and generator fields were energized from a constant-voltage bus, and the field currents were controlled by resistors and contactors in the field circuits.

During recent years approximately ninety per cent of the ingots rolled on this mill measure 25 × 30 in. The remainder consists of 23 × 29 in. and 34 × 34 in. hot-top ingots, and 22 × 34 in. slab ingots. Approximately sixty per cent of the 25 × 30 in. ingots are rolled into blooms for rails. These high-carbon rail ingots and forging-quality, hot-top ingots require careful heating and some special handling equipment.

Presented before AISE Philadelphia District Section Meeting, February 5, 1949

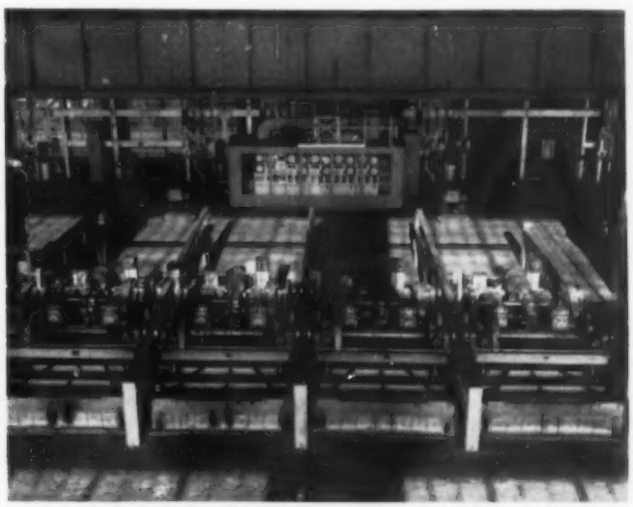
PIT FURNACES

In 1946 construction work was begun on new soaking pits and improved ingot-handling facilities. Sixteen top-fired, recuperative-type soaking pits, each 16 ft long by 7½ ft wide by 11 ft deep were built. They have a total capacity of 1250 tons of ingots. These pits are all arranged in a row, grouped in four batteries of four holes each.

Each pit has one burner located in the end wall three feet from the top. The fuel is burned above the top of the ingots, and the gasses of combustion are exhausted

Figure 1 — General view of the soaking pits which were built in 1946.

Figure 2 — The soaking pits are equipped with automatic temperature, fuel-air ratio, and pit-pressure controls.



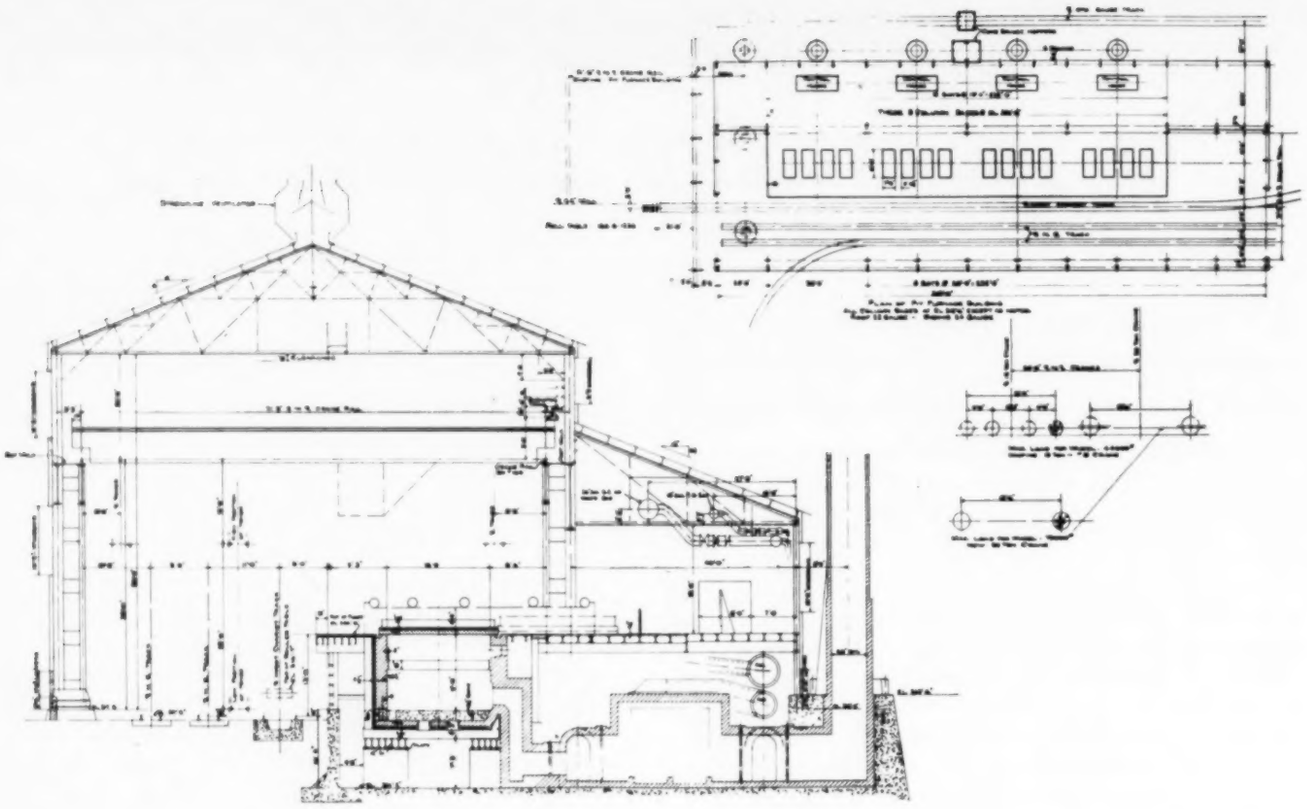
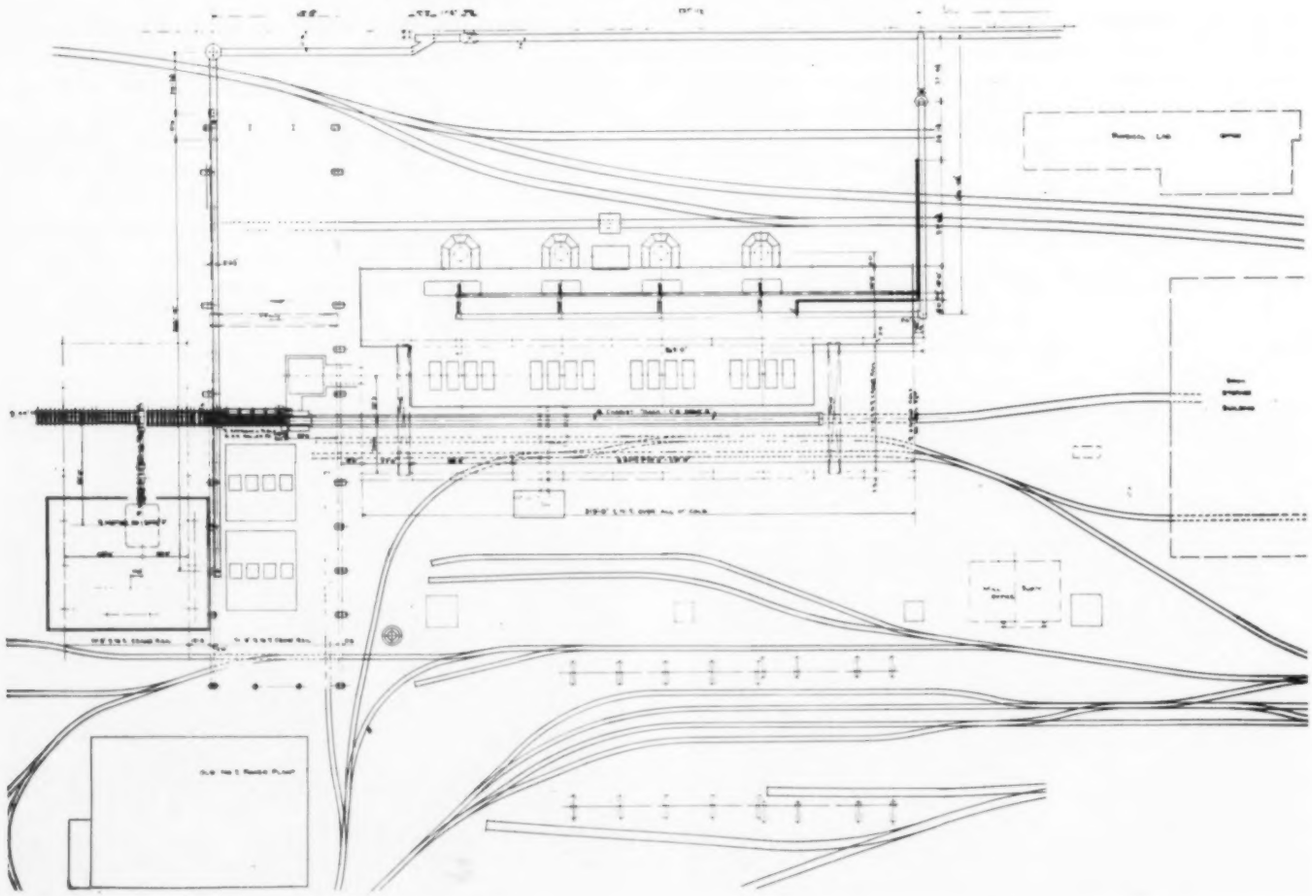


Figure 3 — Cross section through pits and pit building.

Figure 4 — General layout of pits and railroad tracks at the 44 in. mill.



through ports located in the end wall below the burner. This burner uses 135-Btu mixed gas, straight coke-oven gas and Bunker "C" fuel oil. The pits are normally operated on mixed blast-furnace and coke-oven gas, but in case of failure of blast-furnace gas they automatically swing over to straight coke-oven gas.

Each pit is equipped with automatic-temperature, fuel-air ratio and pit-pressure controls. The temperature control permits top rate of firing until a thermocouple in the pit wall is heated to the desired temperature when the firing rate automatically cuts back to balance the rate the steel is soaking up heat. At the end of this cycle, the gas flow stops decreasing and remains practically constant. The point where this occurs can be read on the gas-flow chart and indicates the time when the ingots are ready to roll.

This type of control used in conjunction with top firing has produced uniformly heated ingots with no evidence of washing. When going from low to high-carbon or alloy steels, the only adjustment required is a change in the temperature setting.

The heating rate of the pits depends a lot on the grade of steel being heated and the temperature of the ingots when they are charged. Our practice is shown in Table I.

TABLE I

Ingot size, in.	Grade of steel	Interval tap to charge	Interval finish charge to ready	Tons of steel per pit per hr	Btu per ton of steel
		hr, min			
25 x 30	Rail	2:45	4:30*	13.6	550,000
25 x 30	18 to 45 carbon steel	2:30	3:30	21.4	452,000
23 x 29	Hot-top ingots	4:00	5:00	13.5	640,000
22 x 34	Slab	2:20	4:00	17.0	540,000

*We aim to hold rail ingots an additional hour for soaking before they are rolled.

Bottoms are made with 18 in. of coke breeze. The pits are emptied of coke breeze on an average of once every 21 days. A 60-ton coke breeze storage is provided at the pit building where coke flows by gravity into drop-bottom boxes. When adding coke breeze, the craneman opens and closes the coke box and levels the bottom without any assistance from a floor-man.

INGOT HANDLING

Noteworthy in the layout of soaking-pit facilities is the method for handling ingots to and from the pits. All equipment is arranged in duplicate to provide continuous operation and still permit necessary repair work in event of a breakdown.

The stripper-crane runway is located adjacent to the pit building and is equipped with two cranes. On one of these cranes is a drop hammer for removing bottoms which occasionally stick to ingots. Ingots are transported on narrow-gage trucks and can be pulled from either end of the runway and shifted into the soaking-pit building on either of two charging tracks.

The pit building is equipped with two pit cranes, two ingot buggies and a drop hammer. One ingot buggy is operated automatically. The other buggy and the drop

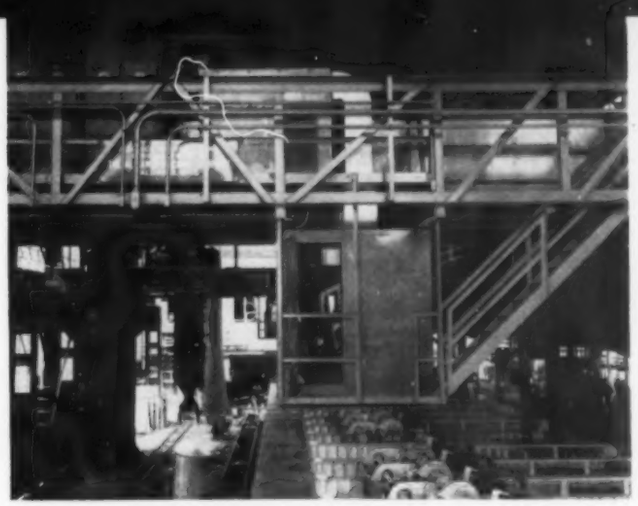


Figure 5 — The mounting of the operator's cab on the bridge is unusual for a pit crane, but it has been found to work out very satisfactorily.

hammer are operated manually. When charging ingots or making bottom, either craneman opens and closes the pit covers from the crane cab. When drawing ingots for the mill he also opens and closes the covers and operates the automatic ingot buggy. The manually-operated ingot buggy is used only for special double-rolled ingots or when the automatic buggy is down for repairs.

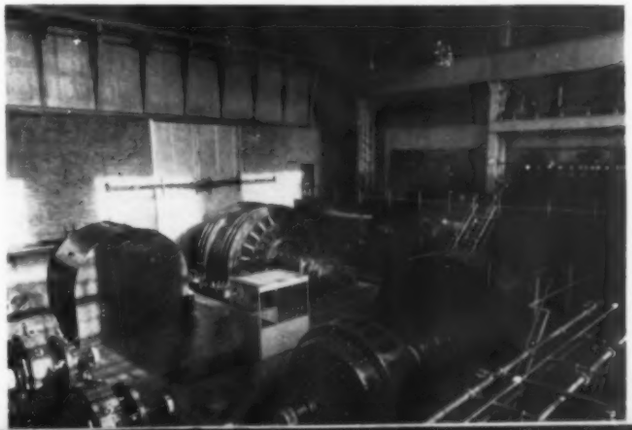
The pit cranes have some features which are a little unusual. The operators cage is stationary and hung from the bridge girders at about the middle of the span. This was done to give the operator better vision, take considerable weight off the trolley, and simplify the installation of air conditioning and control wiring. Each crane is also equipped with a small radio transmitter and receiver which permit communication with the other crane and with various points around the mill.

MILL MOTOR CONTROL

A new type of control was installed in the field circuits of the blooming-mill motor and generator. It consists of separate exciters for the motor and generators, and a group of rotating regulators. When the mill is operating, the control very materially increases the rate of magnetic flux changes in the motor and generator field circuits. It also limits to a safe value the regenerative current produced by the motor during reversal.

From an operating point of view the outstanding features of this control are, the reduction in time re-

Figure 6 — New control was installed which reduced time required to reverse the drive motor.



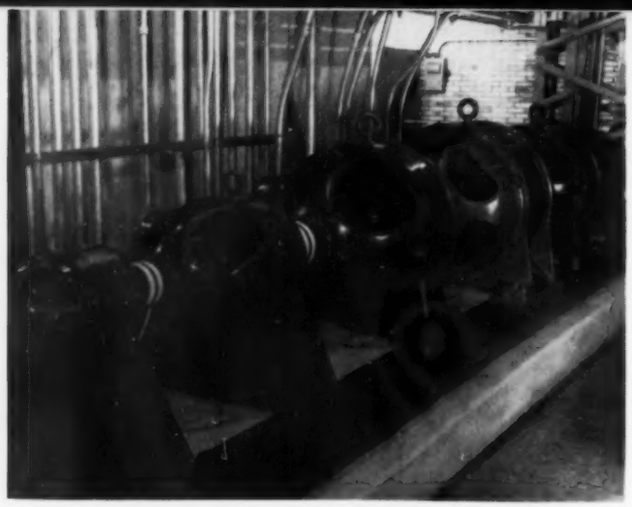


Figure 7 — The new control installed consists of separate exciters for the motors and generators and a group of rotating regulators.

quired to reverse the motor and the smaller amount of maintenance work required on the motor and generator commutators. We regularly reverse the motor now in approximately two seconds. This saving in time has helped us to increase the tons-per-hour off the mill. The reduction in maintenance work is also very important to us since our drive motor has been in use for twenty-seven years.

The rolling rate on this mill as expressed in tons per hour varies with the size of blooms produced. For ordinary carbon blooms and billets, our average production for the year 1948 was 133 tons per hour including mill delays. A typical eight-hour turn will average 165 tons per hour. Rail blooms averaged 119 tons per hour, and slabs 96 tons per hour for the past year. The tons-per-hour for slabs will be increased with the installation of a new control on the screw-down motors.

BLOOMING MILL TABLES

New main tables and feed rollers have been purchased for this mill. Our old tables were installed when the mill was built and have required a large amount of maintenance. The new tables, in addition to being replacements for the old ones have a number of important design features. They are as follows:

1. The main table rollers are solid forgings and mounted on self-aligning roller bearings.
2. The line shafts are made of hot-rolled steel and are supported in the gear case on cylindrical roller bearings. Thrust is handled by a taper-roller thrust bearing.
3. All anti-friction bearings are enclosed in cartridges and the cartridges bolted to the table frames.
4. There are two feed rollers with separate drives on each side of the mill. The first roller on each side is driven through a controlled-torque clutch.

With the exception of the new tables, the equipment described in this paper has been in operation for over two years. During this time ample opportunity has been provided to demonstrate its reliability.

Figure 8 — The new control increases the rate of the magnetic flux changes in the motor and generator field circuits.

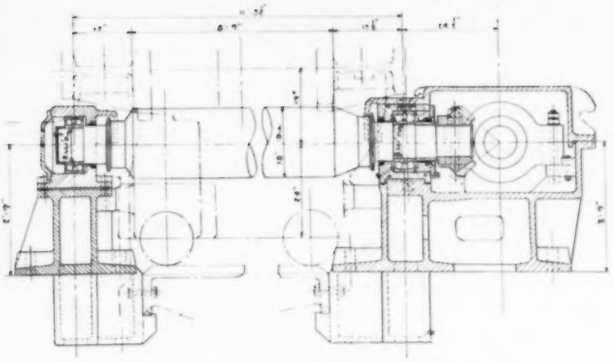


Figure 9 — Cross section through 44 in. mill table.

DISCUSSION

PRESENTED BY

ROBERT MILLER, General Foreman, Electrical Department, Bethlehem Steel Co., Sparrows Point, Md.

J. S. MORRIS, Special Engineer, Lukens Steel Co., Coatesville, Pa.

JOHN DEIMLER, Electrical Engineer, Alan Wood Steel Co., Conshohocken, Pa.

W. N. HORKO, Engineer, Henry Disston's Sons Co., Tacony, Philadelphia, Pa.

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

JOHN C. REED, Retired, Steelton, Pa.

E. T. PETERSON, Chief Engineer, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

HERBERT PORTER, Roll Designer, Phoenix Iron Works Co., Phoenixville, Pa.

RUSSELL M. WEIGLE, Assistant Superintendent of Rolling Mills, Bethlehem Steel Co., Steelton, Pa.

Robert Miller: I want to ask whose air-conditioning equipment do you use in your crane cabs, and how long have you had the new one in operation? What changes did you find necessary to make in your crane cabs and what has been your maintenance experience?

J. S. Morris: On the figure showing the cross section of the new tables, I noted that bevel gears were used to drive the rolls. I would like to know whether the teeth

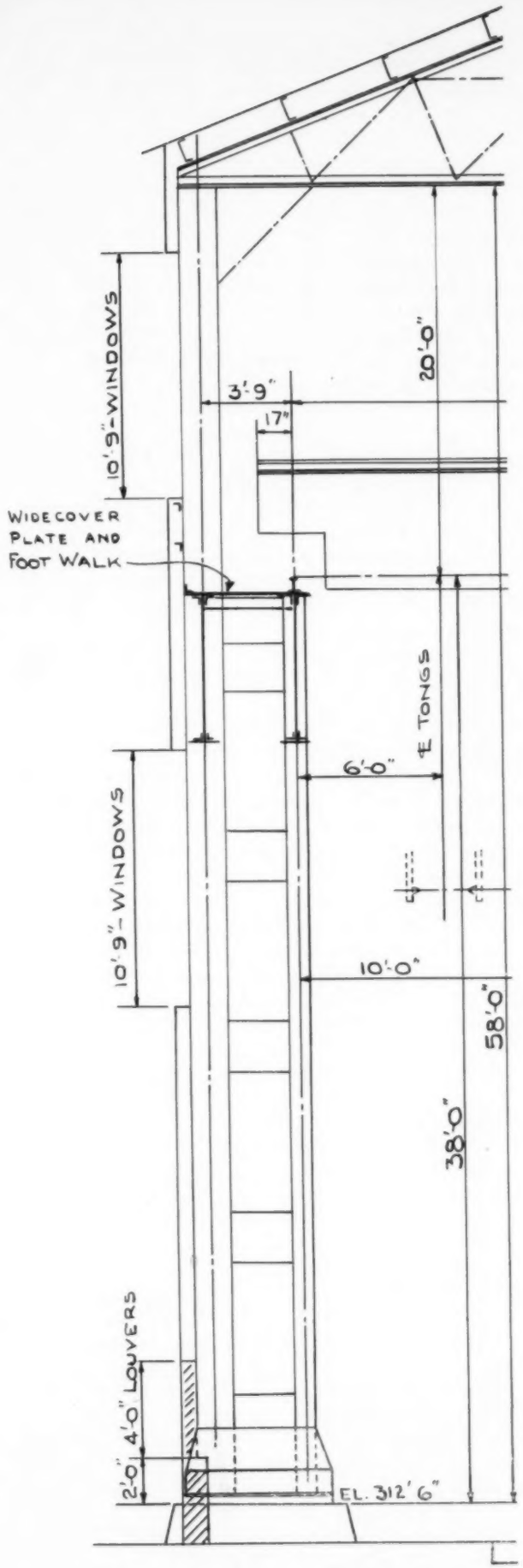


Figure 10 — The buildings have double columns, one of which supports the building itself and the other supports the crane runway.

of these gears are surface hardened, or whether they are in the as machined condition.

John Deimler: The system of control for your pit covers from the cage of the crane seems to be a rather novel idea. I would like you to explain this point in more detail.

Wm. N. Horko: I would like to ask Mr. Weigle two questions on the soaking pit burners. Do you burn oil and gas through the same burner or do you have separate burners for the two types of fuel, and is it felt that the combination of oil and gas heat adds something to the atmosphere, that is, to the quality of the atmosphere in the soaking pit?

L. F. Coffin: Will you give the frequency of cleaning your pit bottoms, and whether you have any difficulty with slag penetration of the bottoms? What type of refractories do you use on the pit bottoms and the breasts.

John C. Reed: I wish to call your attention to some points not brought out in the paper. The first is the design of the building and crane runway. From Figure 10, you will note the building has double columns, one of which supports the roof trusses, the other the crane runway. These columns are tied together to obtain stiffness, but they are essentially separate so that it would be possible to take down the building and leave up the runway, or vice versa. The crane runway girders are constructed with a very wide top cover plate, with angle stiffeners, so that the girder is nearly as strong laterally as it is vertically. This reduces the lateral movement which takes place in the ordinary design of crane runway girders. I have had forty-five years' experience in the maintenance of a great many cranes, and have found that crane runway girders frequently do not have sufficient stiffness laterally, with the result that with heavy trolleys on the cranes and much trolley movement in the operation, the lateral movement of the top of the crane runway girders causes the vertical web plates to bend back and forth. After some years, they will start to crack near where they are attached to the columns. I have never known a crane runway girder to fail in the center of the span but have known of many failures near the columns.

These wide cover plates also assure a good wide footwalk the length of the runway to facilitate making crane repairs, especially the changing of track wheels, etc. They are helpful in the maintenance of the electrical conductors which are placed above the walks where they can be kept clean and are easy to get at in a safe manner.

I explained all this to one of my old friends, an electrical superintendent of one of the western mills, at our recent convention in Cleveland. He thought it was an excellent arrangement but wondered how I got the manager to approve the additional expense. I told him that the increased cost would be a very small percentage of the overall cost of a soaking pit installation. I also had used some strategy in the matter, in that every time I made a crane clearance drawing, I would show the building constructed this way so the management had become used to looking at it, and in time came to think that was the way it was. Furthermore, if you are a good salesman and have an intelligent and progressive manager, you should be able to sell it, and if you can not, it might be a good idea to get a new manager.

The other point about which I wish to call to your

attention is the location of the crane cage on the bridge of the crane in place of on the trolley. Forty or fifty years ago, we started placing the cages on the trolleys because the arrangement of soaking pits was such as to necessitate the cage being located on the trolley in order for the operator to get a clear view of the bottom of the pits. More recent designs, however, no longer make this necessary. We had in operation an old soaking pit installation used as an auxiliary place to heat ingots, in which the cage was located on the bridge of the crane. We knew that the operator could handle ingots much faster than he could on the more recent installation where the cages were on the trolley. This was due to the fact the trolley was much lighter, not having to carry the cage and controllers. In this new installation, we wanted to air condition the cage, and this would add still more equipment to move around if the cage remained on the trolley.

This idea of placing the cage on the bridge was sold to me by Charles Ewing, electrical foreman of the rolling mills, a practical man for whose ideas I had learned to have very profound respect, so when he came to me with the suggestion I gave it every consideration. My first reaction was that the operator would not be able to see all he should see, but I agreed to have a study of the feasibility of the plan made on the drawing board. We laid it out but it is difficult, where you have a three dimension proposition, to be sure that you have not made a mistake, so in order to confirm our findings on the drawing board, I decided to check it in a practical manner. We had an old bessemer blowing engine building which was very high due to the engine having been of the vertical type. There was a small repair crane over this engine. I had a carpenter make up wood crates of the same size as the proposed pits and set them just as they would be in the mill. We made a wooden cage the same size and shape we proposed to use, and placed all the master switches, etc. in it including a very comfortable seat for the operator. We then hoisted up this cage with the repair crane, and put it at the exact position with respect to the simulated pit that it would occupy on the crane in the mill. We found we could see the entire bottom of the pit and we knew the scheme was feasible and, as Mr. Weigle has stated, it works to everyone's entire satisfaction.

I mentioned above that we wanted to air condition these crane cages and we gave this matter considerable study. Since the crane cage is never over the pit, this helps a lot in making the requirements of the air conditioner as small as possible. We also made our cages as small as possible and construct them the same as the electric refrigerator in your kitchen. They have inside and outside metal lining, and there are no metallic connections. The intervening space is well heat insulated. The windows are all double glass with the intervening space hermetically sealed, and the doors close air tight.

Most crane cages are too large and are not well thought out. The facts are you need but little more room to operate a crane than you need to drive an automobile, so we made the cage small, gave the operator a comfortable chair to sit in, and placed the master switches in such position that he can operate the crane in a relaxed position. This crane cage is by far the most comfortable place in the mill, so we have no trouble keeping the crane operator in it.

E. T. Peterson: There are two points in the paper that interest us as builders of mill equipment. One was the question of putting the roller neck bearings in cartridges. We seem to hear a lot of discussion about that. The cartridge construction is always the safer, but it is more expensive, and when people have a budget for a mill they are always questioning things such as that.

I have never heard of a case where the neck bearings actually pounded into the table girder, although a lot of people seem to be afraid of such an event, and I wonder, considering the way your girders are built, if you have had any experiences of that kind, or if not, why did you go to the cartridge construction?

Another point that interested me was the slip clutch on the feed roll drive. That seems to be another sore point in blooming mills. A lot of people do not seem to be able to keep the feed roll going, for one reason or another. We have heard of people using slip clutches, and some are using an idler sleeve roller on a fixed shaft. Most of those things seem to be a source of trouble. We have always felt that a good substantial gear drive, with a motor that is sufficient to operate the roller, but is not oversize, is a good solution.

The bloom coming out of the mill stops the feed roller momentarily and a large motor produces a terrific inertia, causing breakage.

Another question often discussed concerns the apron between the roll and the feed roller. Some people feel if you put an apron in there, you avoid a lot of the punishment that the feed roller has to take. Other people say that they will not have an apron in there; that the scale piles up, and there is no way to get rid of it. I would like to hear the experiences of Steelton on those matters.

Herbert Porter: In view of the production statistics on this mill, I was wondering what the smallest practicable bloom size is for the mill, and what the pitch diameter is of the pinion drive.

Russell M. Weigle: The air conditioning equipment on our soaking pit cranes, have been in operation over two years and have gone through two summers all right. These units are also used during the winter months to provide air circulation in the crane cabs. During the cold weather we take the units down for inspection and any necessary overhauling.

The crane cages used in connection with this equipment are completely insulated and made as small as possible.

The teeth on the bevel gears of our blooming mill table are surface hardened. We have done experimental work with various types of surface hardened gears, and our records show them to be a good investment on heavy tables.

On the control of pit covers, we have all our pits in line as can be seen from the illustrations. We also have a third buss running parallel to the two main feed rails. This third buss is cut between each pit, and an insulator inserted to provide a continuous surface for the collector shoe. When a craneman desires to open a certain cover he places his crane in front of that cover. He then pushes the cover controller into the forward position and holds it there until the cover is as far open as he desires. If the controller is brought back to center, the cover stops opening. When the craneman wants to close

the cover he pushes his controller to the closed position for only an instant and the cover automatically closes even though the crane has been moved to some other position before the closing cycle has been completed.

Our soaking pit burners are equipped to burn mixed coke-oven and blast furnace gas, straight coke-oven gas and bunker "C" fuel oil. However, each type of fuel must be burned by itself and not in combination with oil. We normally operate on 135 Btu mixed gas. However, if the mixed gas pressure drops below a certain point, the control automatically swings over to straight coke-oven gas. If we want to change over to oil, it requires a manual operation which involves taking a cap off the back of the main burner and inserting a separate oil burner.

Our soaking pit bottoms are lined with nine inches of number one fire brick and two and a half inches of insulating brick. Nine inch chrome brick are used in the walls for a height of two feet.

We clean our pit bottoms on an average of once every twenty-one days. However, this is not a fixed interval. Every time we draw a heat, the heater helper looks in the pit to inspect the bottom. If additional coke breeze is needed, it is added. If it looks as though the bottom should be tapped he will make a note of it, and the first opportunity we have, depending on how steel is coming from the open hearth, our coke breeze and slag men will clean the bottom. We have had no difficulty with slag penetration of the bottoms.

We chose the cartridge type of construction mainly because this is a blooming mill table and must be kept running. When all parts are assembled and protected from dirt, the down time due to repairs is kept to a minimum.

The controlled torque clutch is installed on the spindle driving the first feed roller. Its purpose is to prevent shock from being transmitted to the feed roller drive. It operates dry and is designed similar to a disc type of brake with a single disc and segments of regular brake-lining contacting each side.

We do not have an apron between the rolls and first feed roller or between the feed rollers themselves. When rolling rimmed steel ingots and hot top ingots, pieces of scrap sometimes break off the ingots. We want these pieces to fall through the table so there will be no delays on the mill.

The smallest bloom size rolled on this mill is 6 by 6 in. However, this is a slow operation and our smallest regular size is 7¾ by 7¾ in. When rolling rail blooms, our commonest size is 9¾ by 8¼ in.

The pitch diameter of our drive pinions is 44 in.

A. H. ARBOGAST WINS AISE AWARD

▲ THE interest in the subject of dust in gases among steel men was demonstrated when the committees and directors of the Association of Iron and Steel Engineers selected the paper: "The Quantitative Determination of Dust in Gas," by A. H. Arbogast, as the first place Kelly Award winner for 1948. This selection was approved by the Board of Directors at their meeting on Oct. 2, 1949. The paper was published in the October 1948 issue of the *Iron and Steel Engineer.*

Mr. Arbogast is combustion engineer at the Bethlehem Steel Co., Bethlehem, Pa. His paper is a valuable contribution to industry's knowledge and practice on what is a very perplexing and vital question. E. C. McDonald, chief combustion engineer, Republic Steel Corp., Corrigan-McKinney division, Cleveland, Ohio, won second place for his paper: "The Use of Oxygen in Open Hearth Furnaces," which was published in the March 1948 issue of the *Iron and Steel Engineer.*

Those who were present at the AISE convention two years ago in Pittsburgh, remember the great interest which this paper caused, and how the audience overflow stretched far into the corridors. Also indicating the interest was the fact that all copies of the March 1948 issue of the *Iron and Steel Engineer* which contained Mr. McDonald's article were immediately sold out. This paper was another example of the AISE's efforts to bring to the attention of the operators and engineers in the steel industry latest practices and developments as they occur.

The third prize went to Ross E. Beynon, well known contributor of data on the various phases of rolling and roll design, for his paper: "Applications of the Basic Principles of Rolling in Roll Design," which was published in the June 1948 issue of the *Iron and Steel Engineer.* Mr. Beynon is superintendent of roll shops at Carnegie-Illinois Steel Corp., South Chicago, Ill. This paper outlined the basic principles which must be considered in setting up passes for the rolling of various shapes.

The Kelly Award carries prizes of $300, $200 and $100 for first, second and third places, respectively. The award was established September 28, 1943 to honor John F. Kelly, managing director of the AISE from 1917 to 1934, and to perpetuate the memory of his achievements in the advancement of the Association.

The award is made each year by the board of directors of the AISE upon the recommendations of the editorial and executive committees of the Association.

Rules of the Award:

1. The Award shall be given annually to the author of the paper, adjudged of greatest value in the advancement of engineering or operating practice in the iron and steel industry.
2. The entries for each judging shall be the papers published in the *Iron and Steel Engineer* during each calendar year, although some may have been presented at meetings in the previous year. Voluntary contributions of papers not presented at meetings but published by the Association are also included in the judging.
3. To be eligible for the Award, the author must be directly employed in the iron and steel producing industry. The author need not be a member of the Association of Iron and Steel Engineers.
4. The Award shall be made at the annual fall meeting following the close of the calendar year.
5. The Award shall be made by the board of directors of the Association on the recommendation of the executive committee of the Association.

High Speed Electro-Hydraulic ARC FURNACE CONTROL

By AAGE GARDE
Research Laboratory
Allmanna Svenska Elektriska Aktiebolaget
Vasteras, Sweden

. . . . the arc furnace control described combines fast response with stability in operation . . . .

▲ A NEW system of high-speed electro-hydraulic arc furnace control is described in this paper. Practical experience with this new regulator has shown that the problems confronting earlier regulator designers have been overcome with great success, and the combination of stability with speed of response, in a manner considered hitherto in theory only, has opened up wide possibilities for the future. This great advance in design presents attractive features, both economic and technical, to the steel manufacturer. Important economic considerations are the increased capacity of existing furnaces resulting from the reduction in melting time, together with the appreciable saving in energy and electrode costs. From the technical point of view, the reduction in current fluctuation with attendant improvement in load factor is of importance.

In the operation of arc-furnaces good electrode control is essential because the energy consumption and the melting time, as well as the load factor presented to the power system depend to a large degree on the speed and precision of the electrode control.

This control is most important during the melting period, since the length of the arc is changing rapidly while the molten metal is running away from the electrode, and in addition short circuits may result from direct contact between the electrodes and the charge. The electrodes melt their way down into the charge, and often serious short circuits result when the surrounding material collapses against the electrodes, which must be raised a long way before the short circuit is broken.

The drawbacks of short-circuits and interruptions are considerable. Interruptions mean loss of time, as no energy is conveyed to the melt, and short-circuits mean both loss of time and loss of energy, because only a very small percentage of the short-circuit power is developed in the melt whereas the larger part is dissipated in the leads and transformers. Short-circuits and interruptions both give rise to disturbances and voltage variations in the power system. The prolonged melting period entails increased electrode wear. Considerable savings in time, energy and electrode costs may thus be attained through an ideal electrode control.

PURPOSE OF THE ELECTRODE CONTROL

The purpose of the electrode control is to regulate the length of the arc in such a way that the power consumption is kept as constant as possible during the melting period. Because the furnace is supplied from a constant voltage source, this requirement is met by maintaining a constant resistance in the arc. As the arc is part of a circuit with constant resistance and reactance, the same result is gained by keeping constant the arc impedance, provided that the sensitivity of the regulation is high enough.

The problem is thus to make a regulator which is sensitive to impedance variations, and to combine it with a servo system which operates the electrodes with the highest possible speed and acceleration in response to the control signals.

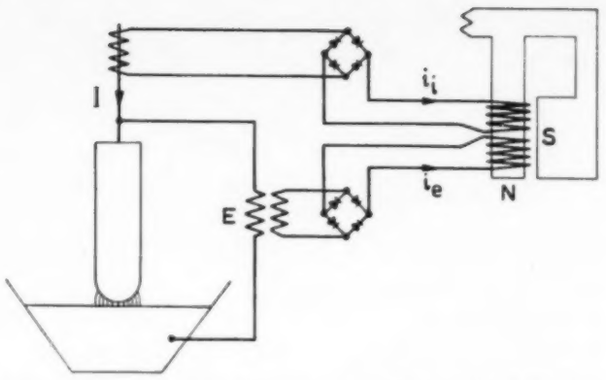


Figure 1 — The wiring diagram shows the path of the two rectified currents in the two halves of the regulator coil.

IMPEDANCE-SENSITIVE SYSTEM

Regulation by constant impedance requires that the proportion between the electrode-current I and voltage E be kept constant:

$$\frac{E}{I}=k \qquad (1)$$

or alternatively

$$E - kI=0 \qquad (2)$$

This equation suggests directly the principle of operation of the regulator, that is, the regulator may be constructed with two coils, one of which is energized with a current proportional to the voltage between the electrode and the melt, and the other with the electrode current. The two coils are working in opposition and are balanced when the impedance is correct.

The diagram, Figure 1, shows the two rectified currents i_e and i_i passing in opposite directions through the two halves of the regulator coil, which is free to move in the air gap of a permanent magnet. The coil is kept in the normal position by a spring, so that a change in impedance results in a proportional displacement of the coil. This spring is adjusted so that the regulator, under no current and no voltage conditions, keeps the valve in the position for slow elevation of the electrode. Thus the first electrode stops automatically, when contact is made with the charge without flow of current, and all electrodes are elevated if the current to the furnace is interrupted.

We will now consider the question of the most suitable servo system for the control of the electrodes.

SERVO-SYSTEM

The operation of the electrodes is normally carried out by electric motors with a Ward-Leonard system of control or by hydraulic control using a servo-cylinder and piston, directly connected to the electrodes.

The hydraulic control is superior to the electric motor control in cases of high-speed regulation with high acceleration, and it is especially so, due to the inertia of the armature of the motor, which requires a large amount of power for high acceleration. In addition the inductance of the generator field requires a high voltage for rapid alteration of the flux and special compensation devices for stabilization of the regulating system.

The drawbacks due to the armature inertia may be readily appreciated by an illustrative example:

Assume an electrode weight of 8,000 lb plus balancing weights of 8,000 lb, or a total of 16,000 lb.

Assume in addition an acceleration time of 0.1 sec from rest to full speed of 0.5 ft/sec, i.e. an acceleration of 5 ft per sec^2.

The required accelerating force is

$$\frac{16{,}000 \times 5}{32}=2{,}500 \text{ lb}$$

and maximum power $=2{,}500 \times 0.5$ ft lb/sec

$$=\frac{2{,}500 \times 0.5}{550}\text{ hp} \quad =2.3 \text{ hp}$$

If we choose a d-c motor 2.5 hp, 1450 rpm, it will have a moment of inertia $I=0.6$ lb ft^2 and we have

angular velocity $=\omega=150$ rad/sec

$$\text{angular acceleration}=\frac{d\omega}{dt}=1{,}500 \text{ rad per sec}^2$$

The accelerating torque becomes

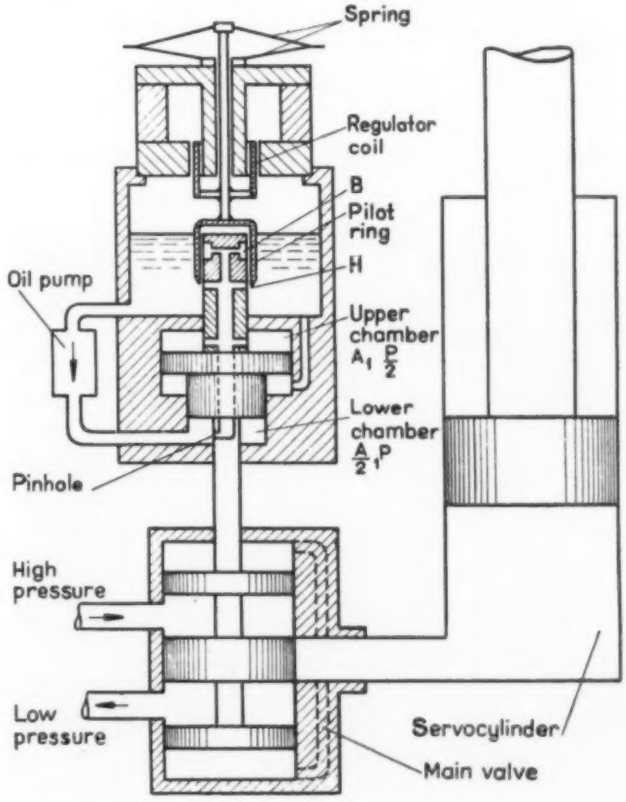
$$I\frac{d\omega}{dt}=\frac{0.6 \times 1{,}500}{32}\text{ ft lb}=28.2 \text{ ft lb}$$

and the maximum power $=$ 28.2×150 ft lb/sec $=\dfrac{28.2 \times 150}{550}$ hp $=7.7$ hp

Thus acceleration of the motor itself consumes about 3 times as much power as that of the electrodes, and the total power is

$$2.3+7.7=10 \text{ hp}$$

Figure 2 — This cross-sectional view of the electro-hydraulic regulator illustrates the operation of the unit.



which means approximately 4 times overload on the motor. Using a larger motor does not improve matters, as the power consumption for acceleration of the armature becomes even more predominant.

Those disadvantages are completely avoided by the hydraulic control system. An acceleration of 5 ft per sec^2 needs only an increase in the balancing pressure of about 15 per cent, which by suitable construction of the system may be obtained by a very small displacement of the valve together with a very short time delay.

EFFECT OF ELASTIC CONNECTIONS BETWEEN VALVE AND SERVOCYLINDER

In the earlier control systems, the regulators and valves were mounted on the control panel and the pressure fluid was conducted from the valves to the servocylinders through flexible armored rubber pipes. In this way, many of the advantages of hydraulic control are lost, since rubber pipes, even if armored, always have a certain amount of elasticity, because their volume is pressure-dependent.

When the valve is displaced suddenly, the corresponding pressure in the servocylinder is not attained until a certain quantity of fluid, enough to expand the pipe to the corresponding volume, has passed the valve. The movement of the servomotor is therefore delayed relative to the valve displacement. On the other hand, when the valve is closed, the servomotor is not arrested immediately, but the movement continues until the accumulated surplus volume of fluid has been dispersed.

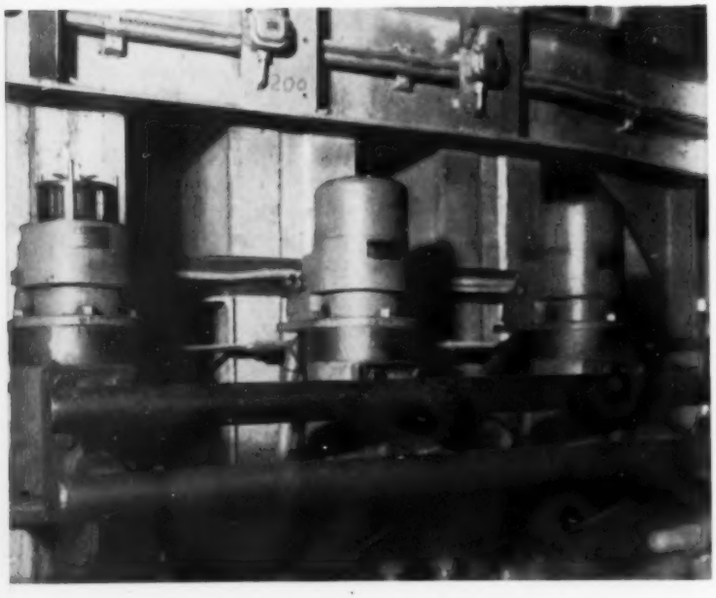
This results in a delayed movement of the electrodes. What is even more serious, the system becomes unstable, even with an absolutely ideal regulator in which displacement of the valve would follow the impedance signals without delay.

This argument is expressed mathematically in the appendix, and in the case of nonelastic connections an equation is derived which represents full non-oscillatory damped regulation.

It shows that even an absolutely ideal regulator will hunt, if an elastic connection is introduced between the valve and the servomotor, but full nonoscillatory damping is obtained if the connection is non-elastic. Furthermore, the adverse effect of the elasticity in the pipes is accentuated by any attempt to increase the speed of operation of the regulator due to the increased pressure required to accelerate the servopiston. The hunting may be damped through suitable compensation devices on the regulator, but only at the expense of the response of the regulator. It is clear that the ideal solution is to mount the valves directly on the portal of the furnace in direct connection with the servo-cylinders. There is no objection to elasticity in the pipes between the valves and the pressure tanks as these pipes are subjected to an approximately constant pressure.

By this arrangement an ideal regulator gives automatic full stability, independent of sensitivity and regulating speed. Unfortunately, it is not possible in practice to produce a perfect regulator; that is to say, one in which the valve displacement follows the signal instantaneously, and thus a certain limitation of the electrode speed is necessary. However, this electro-hydraulic regulator, represents a type which has demonstrated its reliability as a speed regulator for water turbines in power stations, and which is suitable for arc-furnace control.

Figure 3 — The three regulators are mounted on the furnace.



ELECTRO-HYDRAULIC REGULATOR

The construction of the electro-hydraulic regulator is shown in Figures 2 and 3. The servocylinder is connected to the high and low-pressure reservoirs by the displacement of the main valve. This valve is hydraulically balanced but requires a relatively large force to operate it due to the reduction in pressure when the fluid is flowing through the valve orifice. Therefore the valve must be operated by an auxiliary servomotor with differential piston, the movement of which is regulated by a pilot valve on the top of this piston rod.

However, the friction between the piston rod and the pilot ring may give rise to hunting of the piston. This is because when the ring opens the holes (H), the piston travels upwards, but due to friction, the ring is carried along with it until the spring overcomes the friction. The ring then slides down, overshoots, closes the holes (H) and the process is repeated in the opposite direction, resulting in continuous hunting.

To avoid this, part of the oil is let out through 4 small balancing-holes (B) in the end of the rod and inside the ring, which forms a thin layer between the ring and the rod, and also centers the ring relative to the rod.

It was found necessary to employ holes having a special form, since normal cylindrical holes gave precisely the opposite effect to that desired.

With this high speed electro-hydraulic regulator in combination with short rigid connections between the main valve and the servocylinder together with a special design of slot in the main valve, full stability is attained, without any compensation whatever, at electrode speeds up to 0.5 ft per sec or more. For

practical reasons the speed has been limited to 0.5 ft per sec upwards and 0.2 ft per sec downwards.

As a result of this type of construction, wear is practically eliminated and, as no intricate compensation devices are incorporated in the regulator, overhaul and maintenance, with the exception of cleaning the oil filters, is virtually unnecessary.

Should the oil pump for the regulator fail, and the operating pressure for the electro-hydraulic regulator fall, a pressure relay blocks the connection between the main valve and the low pressure tank. Due to leakage in the main valve, high pressure is produced in the whole servosystem, independent of the position of the valve, and the electrodes are elevated.

The risk of inadvertently increasing the carbon content of the melt by immersion of the electrode is thus eliminated.

MANUAL CONTROL

For manual control of the electrode, the regulator coil is connected between the midpoint of the auxiliary battery and a potentiometer across the battery. In the mean position of the potentiometer, the valve is closed and the electrode is stationary, and the speed of the electrode is very nearly proportional to the setting of the potentiometer.

HYDRAULICALLY BALANCED ELECTRODES

The electrode is moved downward by its own weight, when the valve connects the servocylinder with the pressure tank. In this way, most of the weight of the electrode may be balanced hydraulically, and no counter weights are necessary. Correct pressure in the low pressure tank will limit the force of the electrode against possible non-conducting parts of the charge, and the risk of electrode-rupture is practically eliminated.

This hydraulic balancing of the electrodes does not entail any increase in the power consumption of the pump, because the pump may be connected between the high and the low pressure tanks, and is operating at the differential pressure only.

PERFORMANCE IN SERVICE

As an illustration of the qualities of the control system, a series of oscillograms are reproduced, showing current, voltage and movement of one electrode at intervals during the melting period.

The furnace was a 12-ton furnace, (Figure 4) operated with 50 cycles from a 5,000 kva transformer, with 5 per cent short circuit voltage. During the first part of the melting period the furnace is operated over a series reactor with 42 per cent voltage drop. During the last part of the melting period, the reactor is reduced step by step from 42 to 4.8 per cent.

The first charge consisted of:

12,000 lb scrap iron
2,200 lb swarf
1,100 lb iron oxide (scale)
900 lb quick lime

The start at 0.00 with a predetermined current of 6,000 amp is shown in Figure 5a. The electrode under observation (No. 1) was the first to make contact with the charge, and neither current nor voltage appear in its regulator coils. The spring of the regulator is adjusted so that the electrode, at no current and no voltage, has a tendency to move upwards at a very low speed, and thus contact is broken between the electrode and the charge.

This is indicated in the oscillogram by the small voltage peaks at points "a." Immediately voltage is applied to the regulator coil, the electrode moves rapidly downwards, as shown in the oscillogram, and the interruptions of contact with the charge have a duration of only about 0.06 sec. At point "b" one of the other electrodes makes contact with the charge, and electrode No. 1 passes current. Shortly after the arc is extinguished, probably because a small piece of material projecting from the charge has been melted away. The electrode now moves downwards with maximum speed (0.2 ft per sec) and after about 1 sec, normal current and voltage are established. Further on, the oscillogram shows how the electrode works successively downwards as the material beneath it melts away, and the impedance alters. At the points "c" and "d" respectively a decrease and increase in impedance result in a fast correcting movement of the electrode. On the other hand, the interval "e" shows a proportional variation in current and voltage, depending upon a disturbance from one of the other electrodes, which does not alter the impedance. In this case regulator No. 1 does not respond and the electrode remains stationary. In this way, each electrode acts independently of variations in the other arcs.

The next oscillogram, Figure 5b, shows the operation of the regulator 14 minutes later, when the electrodes have worked their way down into the charge. The oscillogram shows a very lively movement of the electrode and many sudden jumps in the current and voltage, which are corrected immediately by the regulator.

Figure 4 — The twelve-ton furnace, on which the test run was made, is operated by 50-cycle current from a 5000-kva transformer.

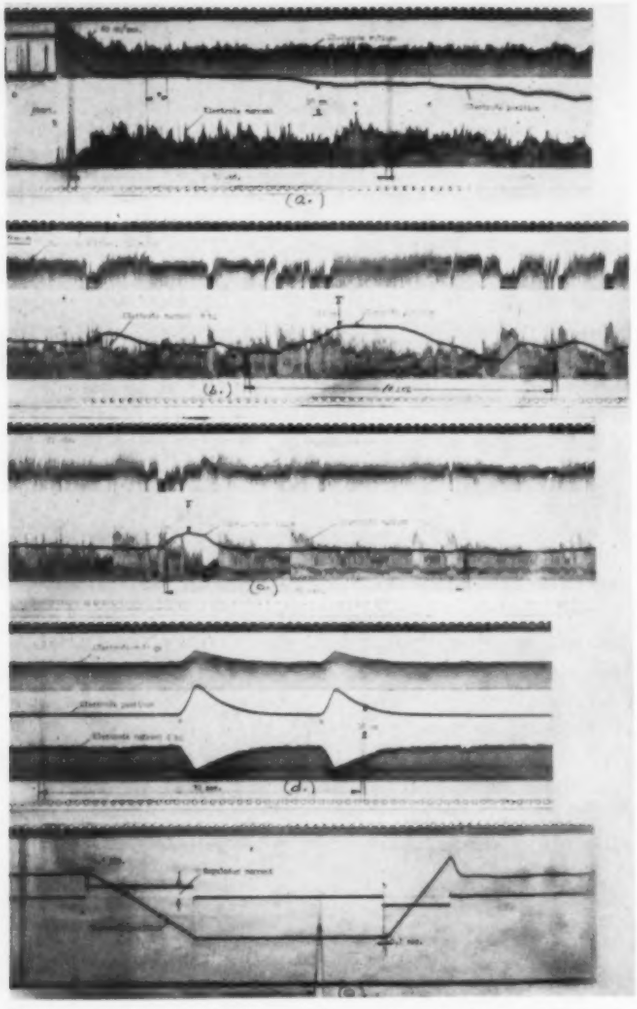
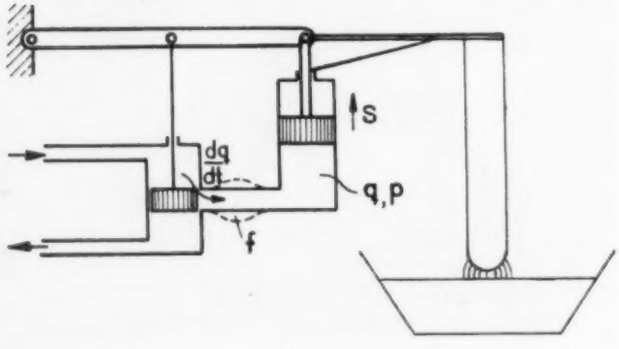


Figure 5 — The oscillogram shows clearly the elimination of hunting by the electro-hydraulic regulator in the operation of the arc furnace electrodes.

After 27 minutes (Figure 5c), the process has settled down, and except for a single disturbance, the electrode makes only small fast corrective movements in order to keep the impedance constant.

When the charge is molten the electrodes are almost stationary (Figure 5d). At the points "a" and "b" the regulator spring has been pressed down by hand for a short moment, and the oscillogram shows that the electrode returns to its normal working position without any oscillation.

Figure 6 — The control scheme is based on the assumption that the impedance of the arc is directly proportional to its length.



The quick response of the regulator is illustrated in Figure 5e. At points "a" and "b" the regulator coil has been connected to a d-c voltage in such a manner that the main valve is displaced respectively upwards and downwards. The oscillogram shows that the electrode attains nearly its maximum speed after a time lag of only about 0.1 sec.

In conclusion, the results achieved confirm that the new electro-hydraulic control system satisfies the fullest requirements of an effective arc furnace control not only in respect of stability but also in respect of rapid response. It should be noted that hitherto it has not been possible to combine these two very desirable features to such a marked degree.

APPENDIX

A mathematical interpretation of the effect of elastic connections between valve and servocylinder.

Referring to the simplified control system shown in Figure 6, we assume that the impedance of the arc is directly proportional to its length, and thus the function of the ideal regulator may be represented by a direct connection between the servomotor and the valve by means of a lever. Further, we assume that the velocity of the fluid $\frac{dq}{dt}$ through the valve is directly proportional to the displacement s.

We get thus:

$$\frac{dq}{dt} = -k_1 s \qquad (3)$$

The volume of the fluid in the elastic pipe (having elastic constant f) and in the servocylinder at the pressure p is equal to

$$q = k_2 s + k_3 f p \qquad (4)$$

and the pressure p gives the electrode an acceleration

$$\frac{d^2s}{dt^2} = \frac{1}{m} k_4 p, \qquad (5)$$

where k_1, k_2, k_3 and k_4 are constants for the system.

Elimination of p and q gives the following equation for s

$$\frac{k_3}{k_4} m f \frac{d^3s}{dt^3} + k_2 \frac{ds}{dt} + k_1 s = 0 \qquad (6)$$

As the coefficient for the term $\frac{d^2s}{dt^2}$ in this equation is zero it will be appreciated that the system will be unstable.

Without elasticity in the connection between the valve and the servomotor the following equations apply:

$$\frac{dq}{dt} = -k_1 s \qquad (3)$$

$$q = k_2 s \qquad (7)$$

$$k_2 \frac{ds}{dt} + k_1 s = 0 \qquad (8)$$

This equation represents full non-oscillatory damped regulation.

TACONITE BENEFICIATION PLANTS

▲ THE Erie Mining Co. on October 13, 1949 applied to the Minnesota Department of Conservation to obtain a sufficient water supply for proposed beneficiation plants with capacity to produce up to 10,000,000 tons a year of concentrated iron ore from taconite, the low-grade iron-bearing rock of which billions of tons exist on the Mesabi Range. The proposed plants would be located on the Mesabi Range near Aurora, Minn.

Erie Mining Co. is operated by Pickands Mather & Co. for the account of Bethlehem Steel Corp., The Youngstown Sheet and Tube Co., Interlake Iron Corp., and themselves.

No final decisions have yet been made as to whether the proposed large plants will be built. The filing of the application for permit was necessary, because the costly and extensive engineering studies required to reach those decisions cannot proceed unless an adequate water supply is assured. If the program goes through as hoped for, the effect on employment in the range communities would be substantial, especially as to mining labor because three tons of taconite must be mined to produce each ton of concentrated ore.

The first large plant contemplated would have capacity to produce 2,500,000 tons of concentrates a year. If this plant should be operated successfully, the plan calls for adding a similar unit bringing the capacity to 5,000,000 tons a year. As further depletion of the available direct-shipping ores makes necessary increased production of taconite concentrates, other units or another separate plant with capacity to produce an additional 5,000,000 tons a year could be added, so that the total plan may involve construction of a plant or plants able to produce 10,000,000 tons of concentrates annually.

The water application asks permission to construct a channel between Upper Partridge Lake and Lower Partridge Lake and various dams, spillways and pumps to form a reservoir from which water at the rate of 12,000 gallons a minute can be piped from Upper Partridge Lake to the proposed concentrating plant or plants. It requests that in view of the magnitude of the project under consideration, limitations upon the commencement of construction work on the dams and other facilities be not shorter than five years.

The plan does not contemplate any interference with the normal level of Upper Partridge Lake. The waste material or "tailings" would not be dumped in lakes, but on wasteland areas north of the range which the company has acquired for that purpose.

For some years Erie Mining Co. has been experimenting at its laboratory at Hibbing, Minn. with processes for obtaining from taconite an iron ore concentrate suitable for use in blast furnaces. Last year it put in operation a "preliminary plant" on the Mesabi Range near Aurora, Minn., using full-scale equipment.

The preliminary plant, with capacity of 200,000 tons of concentrate per year if run continuously, has up to now been operated intermittently for the purpose of making equipment tests. Experience to date, indicates that if the larger plants are built, they will be designed to use processes similar to those used in the preliminary plant. Various types and combinations of equipment are being tried, and the processes used up to this time are subject to change as experimentation continues.

Taconite is the hardest material mined at the Lake Superior district and places a severe strain on all of the equipment used in handling and processing it. For this reason, and also because three tons of taconite must be processed to obtain one ton of finished product, special emphasis must be placed on cost control.

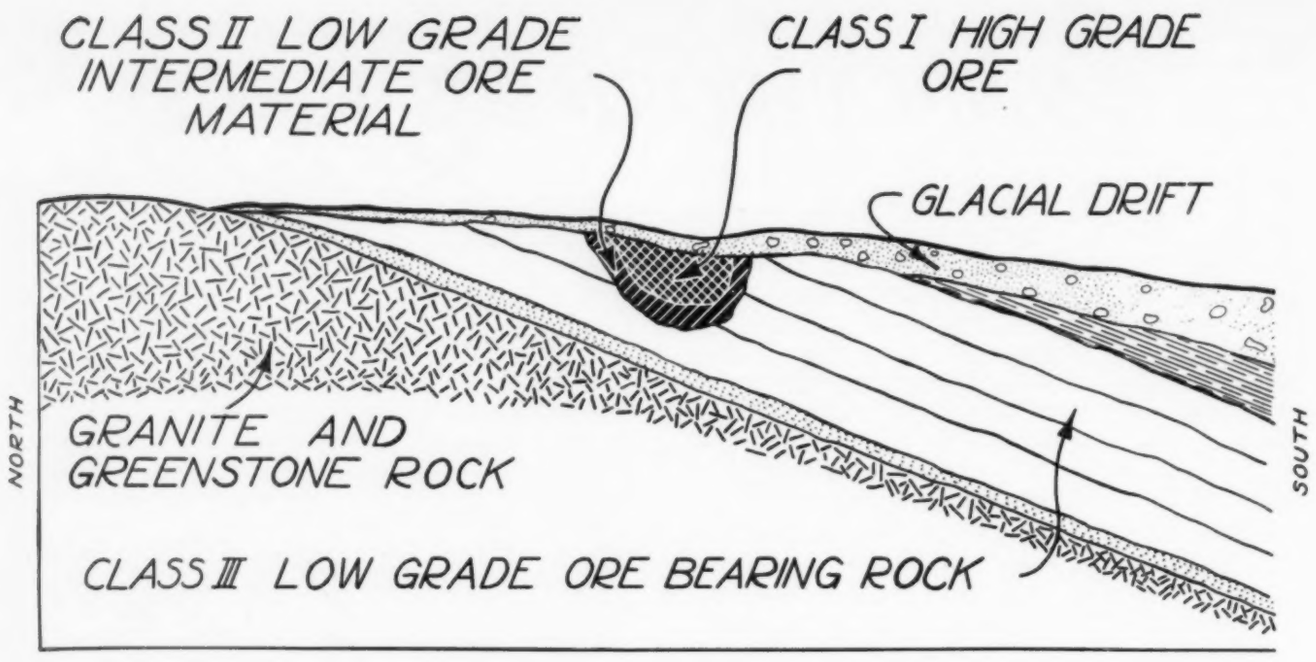
In the first step in the process, the drilling of blast holes, the Erie company is experimenting with jet piercing drilling. This method cuts the blast holes with a high-velocity kerosene-oxygen flame accompanied by a water spray. Early tests indicate that the jet piercing equipment will prepare holes many times as fast as conventional drills. It also eliminates the need for bit-sharpening shops and difficult handling of large bits. After blasting, the rough blocks of taconite are picked up by large Mesabi-type electric shovels equipped with 4-yard dippers having great shock-resistance, and trucked to the concentrating plant. Magnetic taconite from the lower cherty horizon of the iron formation, obtained from the eastern part of the Mesabi Range, in the area between Aurora and Babbitt is now being used in the preliminary plant.

The manufacturing procedure now being used in the plant is generally as follows:

The blocks are put through three sets of crushers which reduce them to pieces less than 6 inches, 1½ inches, and ⅝ inch, respectively, the material traveling through the series on conveyor belts. After the third crushing, the material is deposited in a 6000-ton storage bin, large enough to store a continuous supply for around-the-clock operation of the subsequent processes.

The crushed material is next fed into a cylindrical 12-ft rod mill, along with water, for preliminary grinding. The grinding operations are designed so that the waste siliceous material will be discarded as quickly as possible to avoid unnecessary grinding. When the ground particles emerge from the rod mill, a magnetic cobber makes the first separation of usable and unusable material, casting off the first "tailings" at this point.

The fine-grinding operation is then performed in a 12-ft ball mill. After a second magnetic rejection of tailings the material goes to a large classifier, resembling a worm gear slanting upward in a water-filled pan. The material which is 100-mesh or finer overflows the classifier, while the larger particles automatically return to the ball mill for further grinding.



Generalized cross section of the iron formation of the Mesabi range.

The minus 100-mesh material from the classifier is next sent through a series of finishing magnetic separators, designed to reject the remaining siliceous particles and to retain the concentrate, which should contain approximately 63 to 65 per cent iron, and represents by weight about one-third of the original taconite. The concentrate then passes through a filter which reduces the water content to about 10 per cent.

There is little doubt that the finely ground concentrate can be sintered according to standard practice but because the material has been ground into the form of powder, it is very desirable that some other and cheaper method be worked out. The process now being tested calls for reassembling of the finely ground concentrate into balls hard enough to stand repeated handling and large enough to serve as a suitable charge in blast furnaces. Many variations in these steps are being tested. The present setup calls for feeding the concentrate into a rotary balling drum, 8 ft in diameter and 24 ft long, where the mud-like particles are rolled into roughly spherical balls from ½ in. to 1½ in. in size. The balls move to the pelletizing furnace and are baked at high temperature, changing from magnetite to hematite in the process.

The finished pellets must have adequate strength to withstand loading in railroad cars, loading into vessels through the chutes of Upper Lakes docks, unloading at Lower Lakes ports, transshipment by rail, and subsequent unloading and handling at the blast furnaces.

TACONITE

The word taconite is derived from a Greek word meaning to melt. Early geologists referred to certain kinds of rocks as taconite rocks, meaning melted rocks. The ancient Pre-Cambrian rocks of Northern Minnesota were referred to by geologists as the "taconic series." When the Mesabi Range rocks were intensively studied, the iron formation was given the name of taconite and it has been retained ever since.

By the word "taconite," in its broadest and most commonly-used sense, is meant all of the Mesabi Range iron formation, bounded by the Pokegama quartzite on the bottom, and by Virginia slate on the top, which is not rich enough in iron to constitute commercial ore by present market standards. This broad definition may be subdivided into various types, such as cherty and slaty taconites; and both of these types in turn may be distinquished as to whether they are magnetic and unoxidized, or have been partially oxidized to hematites or limonites. (Stephen Royce.)

The principal deposits of taconite are found in a strip along the Mesabi Range a little more than 100 miles long, in a formation having an average thickness of nearly 700 feet, and with an average breadth of outcrop ranging from one to three miles.

From a legal or tax standpoint, a somewhat different classification is used and the following definition of taconite appears in the Minnesota tax laws:

"Taconite is defined as ferruginous chert or ferruginous slate in the form of compact, siliceous rock, in which the iron oxide is so finely disseminated that substantially all of the iron-bearing particles or merchantable grade are smaller than 20 mesh. Taconite may be further defined as ore-bearing rock which is not merchantable as iron ore in its natural state, and which cannot be made merchantable by simple methods of beneficiation involving only crushing, screening, washing, jigging, dry or any combination thereof."

Taconite concentration has been attempted on a commercial scale once previously, and a plant was erected at Babbitt, Minn. during World War I and was operated for some years. It made a high-grade product but was unable to operate at a profit with the equipment and under the conditions existing at that time. It was closed in 1924.

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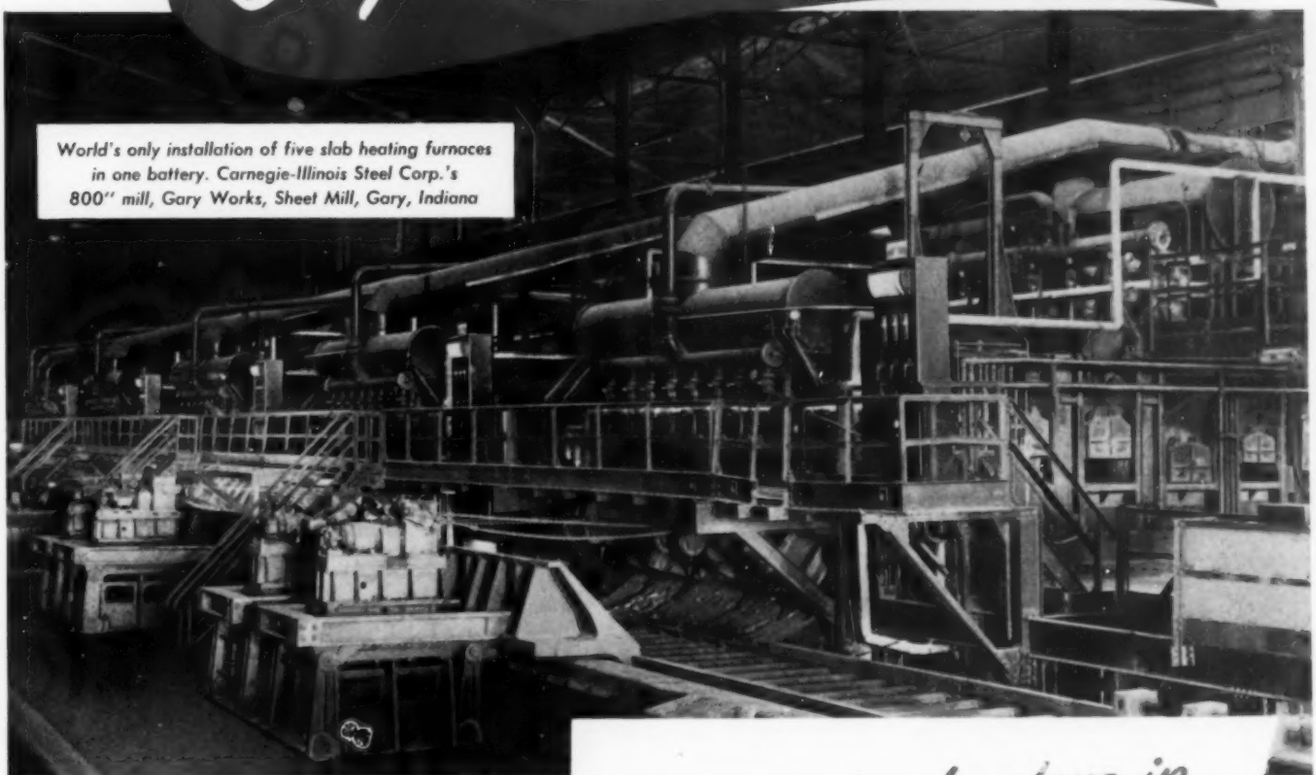

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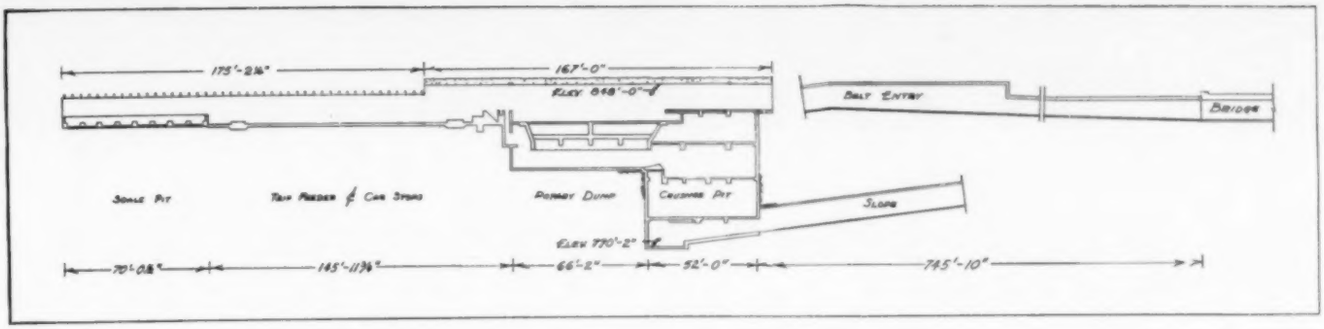

WORLD'S LARGEST UNDERGROUND COAL PREPARATION PLANT

By A. J. MORRISON

Dravo Corporation

Pittsburgh, Pa.

▲ An underground chamber of reinforced concrete to house the crusher for the world's largest coal processing plant, was completed recently for Jones & Laughlin Steel Corp.

The ultimate overall development, located at East Fredericktown, Pa., will handle the entire coal production of J&L's Vesta Mines No. 4 and No. 5. Coal, received by belt conveyor bridged 1000 ft over the Monongahela River, will be sized, cleaned and blended in preparation for storage and dock loading into river barges.

The initial operation, crushing to conveyor size, takes place in the mine near the river portal. Train loads, delivered over a double track system, are handled through photostatic scales and trip feeders to twin rotary dumps, which discharge into a common storage bin. A plate conveyor then passes the coal to feeders and chutes leading to the crushers. A slope belt carries it out to the portal and bridge.

Distance covered from the scales to the bridge is 1087 ft and the installation described is termed, "Vesta Coal Preparation Plant, Underground."

Housing for the scales and trip feed consists of a rectangular haulage-way 33 ft-6 in. wide and 13 ft-3 in. high, with concrete sidewalls and center wall. The length of this section is 175 ft. Adjacent to the scales and trip feed are the rotary dump and bin opening, enclosed in concrete sidewalls and double radius concrete arch roof. The bin pocket below the arch sidewall is 18 ft wide, 22 ft deep and 64 ft long. The crusher room, next in sequence, is covered by a continuation of the typical arch and is 33 ft-6 in. wide and 78 ft deep from crown to the bottom. The total length of this installation is 167 ft under concrete arch. The belt slope and belt entry connecting the crusher pit with the surface are 18 ft-9 in. and 13 ft wide respectively, by 7 ft-3 in. high. Length of the slope is 567 ft of 12 per cent grade, and 190 ft on the level.

Due to the nature of the rock encountered, fair sandstone roof with measures of rotten slate overlying the coal, and fire clay and shales below, the method of construction procedure adopted was to complete first the concrete arch section and 7.15 ft of sidewall throughout its length of 167 ft. This eliminated the hazard of falling rock and the necessity for maintaining temporary roof support while the 60 ft depth construction for the crusher pit below was in progress. It permitted the installation of a shop crane, riding rails attached to the sidewalls, to service this work.

Drift access into the mine to the point of operation was approximately 1500 ft from the entrance. The low 6 ft head room and a congested portal would have made awkward concrete transportation. Therefore, a 10 in. cased hole was put down 92 ft from the surface and bottomed in the entry 80 ft from the work. Ready-mix concrete was dropped down the hole to a small storage bin. It was placed pneumatically in sidewalls and arch, in two separate operations, by means of two ½-yard placers, one serving each side. The sidewall forms were of wood construction, 30 ft monoliths, while the custom-built arch form was of steel, 25 ft long, collapsible and traveler mounted.

Upon completion of the arch, the crane runway, brackets, beams and rails were installed along the sidewalls for a length of 160 ft. Excavation below the coal for the rotary dump and crusher room then was started. Muck was dropped down a 10 × 10 ft glory hole to the bottom and loaded out the slope in mine cars, disposal following routine mine procedure.

During the excavation, installation of concrete walls in the scale pit and trip feed continued without delay. Ready-mix concrete, dropped to the pneumatic guns, was conducted over the excavation pit through two 6 in. blow lines supported on the crane runway beams. The maximum length of blow was 430 ft.

Virtually all of the forms for the rotary dump and crusher room wall panels, beams, and floors were fabricated outside. They were built in lifts, maximum 10 ft, with vertical bulkhead joints only where the design required. The concrete was blown 80 ft from the down hole to a storage hopper at the edge of the pit, and transferred to a one-yard concrete bucket for crane placement.

Concreting in the slope was done in three steps: 1. sidewalls to completion, 2. the roof slab, 3. invert. Forms for the roof slab were suspended from cross beams placed atop the sidewalls for roof protection. A double barrel, tunnel type pumping unit was used for placing the concrete. The maximum length of discharge line was 800 ft. Sidewalls were completed in mild weather with 1:2:3 mix, 4 to 6 in. slump, 1½ in. gravel duraplastic cement, without incident. The roof slab was placed under confined and awkward working conditions during a period of hot weather. The initial set seemed to overtake the concrete before emerging from the 8 in. discharge line. This was remedied by cooling the stockpile aggregates by wetting, and adding one pound of plastiment per sack of cement.

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FORSTER ELECTRIC COMPANY,
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Publication Service...

NOVEMBER, 1949

(1) Super-Centrifuge Data

Operating details, specifications and application data for the complete line of Sharples super-centrifuges has been released in new bulletin. The new bulletin includes basic information on the centrifuge principle, maximum utilization of centrifugal force, operating features, and specifications on all forms and models, both for general and specialized industrial application. Also included are details of "Enbloc" purifiers, laboratory and portable super-centrifuges in open-type and "Vaportite" designs. (1248) Sharples Corp.

(2) Engineering Manual

Just released is a 16 page engineering manual on a new line of "Maxi-Power" enclosed helical gear drives. It contains complete ratio information, horsepower rating tables, simplified selection procedure, overhung load capacities, assembly diagrams, dimensions and weights of single, double and triple reduction units. Features of this new line of speed reducers include improved accuracy of gear tooth generation, higher quality materials, improved heat treatment, closer manufacturing tolerances, reinforced housing design and many other improvements that permit the selection of a smaller size, lower weight unit than was previously possible. (MPA). Foote Bros. Gear and Machine Corp.

(3) Roll Turning Lathe

Marking a major contribution toward simplifying and speeding up contour turning of steel mill rolls, the newly developed template-controlled Monarch roll turning lathe is the subject of a well-illustrated, 12-page booklet just off the press. The bulletin describes how this latest equipment advance in the art of contour turning of steel mill rolls has been specially designed to provide an economical answer to the triple problems of (1) reducing floor-to-floor turning time, from ⅓ to ⅙ of that required heretofore, on rolls of all types lending themselves to this improved turning method; (2) eliminating hundreds of form tools needed with previously conventional techniques, effecting sizable savings, through the use of standard carbide cutting tools; (3) eliminating the need for matching rolls in pairs, by making practical template control of contour forming.

A development based chiefly on the production-proved performance of Keller controls applied to more than 1200 Monarch lathes during the past 20 years, the Monarch Roll Turning Lathe is available in two lengths to accommodate maximum overall length of rolls up to 102 in. or 126 in., and is capable of turning within these ranges an infinitely diverse variety of shapes on the roll face as well as handling necks at the same setup, the booklet also points out.

In addition, 11 built-in performance features of the machine are comprehensively yet concisely reviewed. Included, too, are representative application data covering four typical passes, six assorted rounds and squares, and four different grooves. Detailed equipment specifications round out the presentation. Monarch Machine Tool Co.

(4) Water Conditioning

A bulletin has been issued concisely outlining products, services and background of a water conditioning firm. The company, a development of the 40-year-old water conditioning division of Graver Tank & Mfg. Co., Inc., has recently expanded its organization in greatly enlarged quarters, including extensive laboratories and a new pilot plant for research in water conditioning for boiler plant, process work and general industrial and municipal use. The bulletin explains the scope of Graver activities in these fields, and is illustrated by some of the company's many large installations of hot-process and zeolite softeners, demineralizers, clarifiers, filters, etc. (WC100). Graver Water Conditioning Co.

(5) Proportioning Oil Burner

A new catalog has been published on the Hauck proportioning oil burner with single lever oil-air control and latest data on spark-gas pilot or straight electric spark ignition, proportional or modulating automatic temperature control and two larger size burners. (410). Hauck Mfg. Co.

(6) Thawing Pits

Besides thawing frozen coal cars, some steel mills are now using their Hauck thawing pits, described in a new catalog, for thawing frozen ore cars. Now that United Mineworkers interfere at any time with coal deliveries, the quick thawing of frozen coal cars will be very important this winter to many plants. (1040). Hauck Mfg. Co.

(7) Blast Cleaning

A bulletin is available telling how Wheelabrator blast cleaning replaces acid pickling for metal cleaning. With more and more manufacturers facing the necessity of providing expensive acid disposal plants for handling waste pickle liquor. There has been an increasing demand for a solution to the metal cleaning problem that will eliminate the need for acid pickling. A detailed summary of the two metal cleaning processes presents the serious problems of using acid pickling for metal cleaning, safety hazards, acid disposal, etc., and compares the benefits obtained by airless blast cleaning in faster and more uniform cleaning, better surface preparation for subsequent finishes, and savings in labor, space and costs. (584).

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

American Wheelabrator and Equipment Corp.

(8) Gas Welding Supplies

The publication of a new 16-page catalog on gas welding supplies has been announced. The new catalog, the first of a projected series of ten, completely describes 19 different gas welding rods, 8 different fluxes, and includes a section on silver brazing alloys plus a page devoted to carbon rods and carbon plates. This catalog is carefully indexed for ready reference and is prepared for binder or loose leaf filing. The text material offers descriptions of the mechanical properties of the various products and recommendations regarding their application. Data on lengths, packaging and available diameters are included for each welding rod. Air Reduction Sales Co.

(9) Rotating Regulator

A new two-page bulletin describing and illustrating a recently developed rotating regulator for voltage and current (tension) regulation has been issued. Known as the "Reliance VSA Regulator," the unit consists of two exciters, driven by a small a-c motor, which perform the functions of recognizing a signal change and amplifying it into usable d-c power for the required speed correction of a motor drive. Applications of the unit include, among others, the rubber, textile, steel, paper, wire, chemical, and non-ferrous industries. Simplified schematic wiring diagrams and pictures covering two typical plant installations supplement the data given on the control generator, amplifying generator, motor, cabinet and controls. (K-2001). Reliance Electric & Engineering Co.

(10) Sealed Ball Bearing

A folder is available describing a standard dimension ball bearing with a removable synthetic rubber seal which keeps out dirt, grit and moisture. (1528-1). Marlin-Rockwell Corp.

(11) Armored Gears

Literature is available describing armored gears that are guaranteed to outlast untreated gears. The gears covered in this literature are bevel, spur, helical, worm and special. Pittsburgh Gear Co.

(12) Power Strapping Machine

A folder is available describing the various types of power strapping machines now available. These machines can drape steel strapping around wire coils, packages, or sub-assemblies, tensions, seals and cuts it in one continuous operation at speeds limited only by the rapidity with which these objects are fed to the machine. It is not known all the things that this new machine can do. It is known, however, that there are many places in mass production industries where this machine, properly used, could speed work, save labor, cut costs. One of its important features is that it fits easily into a conveyor line. Another is that the tension of the strap is adjustable. It is believed there are a number of men in the steel industry with the vision to see how these machines might be used in their assembly line or volume packaging operations to do an old job in a new and better way. To such men, copies of this literature is offered. Signode Steel Strapping Co.

(13) D-C Brake

A bulletin is available on a new 2-shoe two-magnet, d-c brake for hoists, cranes, bridges, conveyors and steel mill drives. This folder tells how this new brake is made to stand up under severe operating conditions. It has been designed to operate smoothly and efficiently. It is designed for floor mounting on G-E motors. Tabular information on brake ratings and dimensions is also included. (GEA-5194). General Electric Co.

(14) D-C Crane Control

A folder is available on the new G-E d-c crane hoist control. This new control is the result of months of investigation concerning industry requirements, and a year and a half of actual testing on the General Electric crane testing tower. To insure the utmost in dependability, the control was subjected to the most rigorous tests which could be devised. As a result of these tests, no matter how erratically the master switch handle is moved, there can be no damage to the equipment. Included in the folder is a description of the hoist control circuit and of the accessories. (GEA-2292-B). General Electric Co.

(15) Centrifugal Compressors

A catalog is available on a comprehensive line of multi-stage units designed specifically for high pressure and large temperature differential duty. These units incorporate the most advanced features in modern centrifugal compression. Performance characteristics are included as well as tabular information and a cross-section view of this centrifugal compressor. Clark Brothers Co., Inc.

(16) Battery Charging Equipment

A folder is available on single-circuit motor-generator, battery-charging equipment. This folder tells how this equipment protects battery performance, assures longer life, and minimizes maintenance. The equipment requires only 8 to 9 hours for complete recharge. (234). Electric Products Co.

(17) Friction Saws

A folder is available describing a new friction saw for high speed volume and production cutting. This new horizontal stroke saw has many new improvements including: (1) effective spark control, (2) proper blade cooling, (3) reduced spillage of water on material being severed, (4) filtration of motor ventilating air, (5) shielding of wearing surfaces from chips and water, and (6) revised method of guiding carriage, allowing permanent alignment of blade. Tabular information is included on cutting data. The approximate cutting time for structural beams, H beams, structural channels, structural angles on edges, rails, rounds, squares and pipe is also included. Kling Brothers Engineering Works.

(18) Air Interrupter Switches

A catalog is available covering air interrupter switches of the indoor type. These switches proved an excellent means for interrupting currents up to 600 amperes at voltages as high as 15,000 volts. Switching load currents of feeders and transformers, interrupting charging currents of lines, cables, and capacitor banks, as well as opening magnetizing currents of transformers are a few of the many uses to which these switches can be put. Diagrammatical sketches with tabular information on each type of switch is included in this

catalog. Electric Engineers Equipment Co.

(19) Blast Furnace Gas Washing

A folder is available describing primary and secondary blast furnace gas washing in one washer. The folder tells how this washing consists of a primary section, a secondary or a fine cleaning section, and an eliminator. It tells how the first installation has been in continuous operation for several years. This unit has been cleaning gas for a set of modern small checker stoves. A description of the operation of this unit is included as well as a cutaway view. S. P. Kinney Engineers, Inc.

(20) Swivel Joints

A folder is available describing ball bearing high temperature swivel joints that has a specially designed metallic seal which greatly increases its efficiency for steam service — either constant or intermittent. The various styles available are described. These swivel joints can be used in blast furnaces, open hearth furnaces, on steam cleaning equipment and many kinds of steam-operated equipment. Chiksan Co.

(21) Hydraulic Presses

A most complete catalog is available describing many types of hydraulic presses for the metal industry. Included in this catalog is information on hydrostatic tube testing machines, pipe bending presses, straightening presses, and many other types of presses. The description of each press forms a separate section of this catalog. Included in this catalog are descriptions of hydraulic valves and other hydraulic operated equipment. R. D. Wood Co.

(22) Industrial Signal Systems

A bulletin is available describing "Panalarms," a new conception in industrial signal systems. According to the bulletin, there are multiple signal and alarm systems with a broad range of use on process work, power plants and many other applications where sound and visual alarms are required to indicate failure or changes off normal. The alarms are designed to make possible safety shut-downs, sequencing or interlocking of plant operations. They may be actuated by any remote switch, thermostat, float-switch, in short, changes in any type of equipment which can be reflected by an electric impulse to open or close a small relay. Panalarm Products, Inc.

(23) Hydraulic Oils

A folder is available describing "Saf-Drive" series of hydraulic oils which have recently been developed to meet the exacting demands of present day hydraulically-operated industrial equipment. The folder describes an entire series of oils processed to insure such desirable service properties as: high viscosity indices, increased oxidation stability, high demulsibility, positive lubricating value, and corrosion and rust preventive qualities. Swan-Finch Oil Corp.

(24) Synchronous Motor

A bulletin is available on "Fabri-Steel," high-speed, synchronous motors with direct, belt, or gear drive. The folder contains construction features and mechanical modifications. The section on construction features is especially concise and complete. (PB 5600-1-349). Elliott Co.

(25) Weight Printer

A new bulletin is available giving technical information on a new "Load King" scale weight printer. This bulletin tells why the Yale weight printer was developed, how it operates, what functions it performs, how it is constructed, and the models available to perform a particular job. It tells how this weight printer can be installed on "Load King" scales equipped with "Magnetrol" mechanism and have 20 in. reading line diameter dial charts. Yale and Towne Manufacturing Co.

(26) Instrument Transformer

A new bulletin is available describing a revolutionary new instrument current transformer, the first to which the butyl-molded technique has been successfully applied. This new transformer is designed for accurate indoor metering and relay services. It is rated 5000 volts at 25-60 cycles. It will be available with single primary in all preferred ratings, 10 to 800 amperes inclusive. (GEA-5274). General Electric Co.

(27) Leather and Rubber Packings

A catalog is available describing "Sirvis" mechanical leather, "Sirvene" synthetic rubber and "Perfect" oil seals. This is one of the most complete catalogs on the various applications of packings, belting, washers and gaskets, bumpers, pads and frictions. If you can use mechanical leather or synthetic rubber products in your department, it would pay you to look through this catalog which will give you many ideas. Chicago Rawhide Manufacturing Co.

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AMERICAN AIR FILTER CO., INC.	BULLETIN 252	Bulletin describes AAF Electro-Cell which combines high cleaning efficiency plus proven savings in operation and maintenance.
51	AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO.		Catalog gives full details on hard surfacing by fusion welding.
52	BACHARACH INDUSTRIAL INSTRUMENT CO.	BULLETIN 740	Contains information on smoke prevention with the Fyrite CO_2 indicator.
		LEAFLET 700	Describes an oxygen indicator employing the Fyrite principle for direct oxygen analysis.
53	BEDFORD FOUNDRY AND MACHINE CO.		Detailed description of Bedford cranes with capacities ranging from 5 to 150 tons.
54	BROWN INSTRUMENTS DIVISION, MINNEAPOLIS-HONEYWELL REGULATOR CO.	BULLETIN SM-1	Detailed information on Electronik control systems.
55	BROWNING AND CO., INC., VICTOR R.	BULLETIN "S"	Describes Browning mill type cranes.
56	BUFFALO FORGE CO.	BULLETIN 3650	Shows how mill type sheares will cut your punching, shearing and blanking costs.
57	CLARK CONTROLLER CO.	BULLETIN 6200	Full details on the latest engineering features of Clark Control Centers.
58	CROCKER-WHEELER ELECTRIC MANUFACTURING CO., DIVISION OF ELLIOTT CO.	BULLETIN SL-620-1	Information on Crocker-Wheeler auxiliary mill motors—their greater efficiency, ease of maintenance and other unique advantages.
59	CUTLER-HAMMER, INC.		Catalog describes the crane hoist control.
60	DE LAVAL STEAM TURBINE CO.	CATALOG 30-16-R	Full details on the complete line of De Laval vertical speed reducers, in both single and double reductions.
61	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 1024	Describes in detail safety disconnect switches for d-c cranes.
		BULLETIN 942	Full details on the advantages of using EC&M Tab-Weld plate resistors.
62	ELECTRIC SERVICE MANUFACTURING CO.		"Keystone Industrial Products," a catalog available giving detailed information on the full line of Keystone insulators, rail shoes, and current collectors.
63	FARVAL CORP.	BULLETIN 25	Full description of the Farval centralized lubricating system.
64	GENERAL ELECTRIC CO.	BULLETIN GEA-4469	Bulletin giving details on how better-cooled, better protected d-c motors can help cut costs in your mill.
65	HAYS CORP.	BULLETIN 48-750	24-page treatise on the instrumentation and automatic control of steel making and heat treating furnaces.
66	HOMESTEAD VALVE MANUFACTURING CO.	BOOK 39-3	Reference book giving full particulars on Homestead valves.
67	HUNT AND SON, INC., C. B.		Catalog available giving full details about the complete line of quick-as-wink lever operated hydraulic valves.
68	JONES FOUNDRY & MACHINE CO., W. A.	CATALOG 70	This 128-page catalog of Jones herringbone speed reducers will help in the selection of reducers.
69	KOPPERS CO., INC., FAST'S COUPLING DEPT.	CATALOG 47	Catalog containing all the facts and specifications on Fast's couplings.
70	LEEDS AND NORTHRUP CO.		Catalog giving full information on the modern way to regulate big furnaces.
71	LINK-BELT CO.	CATALOG 2550	Descriptive and engineering data on ball and roller bearings.
72	MESTA MACHINE CO.		Book containing illustrated views of the Mesta plant, together with installation photographs of Mesta rolling mills, auxiliary equipment, and heavy duty machine tools.
73	OKONITE CO.	BULLETIN IS-1037	Okolite-Ikoprene's electrical operating advantages, installation advantages and design advantages are given along with dimensional data in this illustrated bulletin.
74	PENNSYLVANIA TRANSFORMER CO.	CATALOG 1492	Contains the who, what, why, when and where on how you can save up to 8% by specifying Pennsylvania standard parts power transformers.
75	POOLE FOUNDRY & MACHINE CO.		Catalog available giving full description and engineering data on Poole's flexible couplings.
76	ROCKBESTOS PRODUCTS CORP.		"The Story of An Insulation" tells how to save money by specifying permanently-insulated Rockbestos A.V.C.
77	SQUARE D CO.	BULLETIN 3100	Bulletin describing Square D's new safety switches, types A, C and D.
78	TAYLOR CHAIN CO., S. G.		"TM Alloy Steel Chain" gives all the facts on the superiority of alloy steel chain.
79	TAYLOR SONS CO., CHAS.	BULLETIN 110	An easy-to-use compilation of Chas. Taylor Sons Co.'s complete line of cements, plastics, castables, patches and ramming mixes for every type of installation.
80	TRABON ENGINEERING CORP.	BULLETIN 484	Bulletin tells how money can be saved and tonnage increased with the Trabon system.
81	WAGNER ELECTRIC CORP.	BULLETIN MU-185	Gives information on the complete line of Wagner motors.
		BULLETIN MU-24	Complete list of Wagner authorized electrical service stations ready to immediately supply on-the-spot service.
82	WARE FUSE CORP.		Circular available on Ware Hi-Lag construction.

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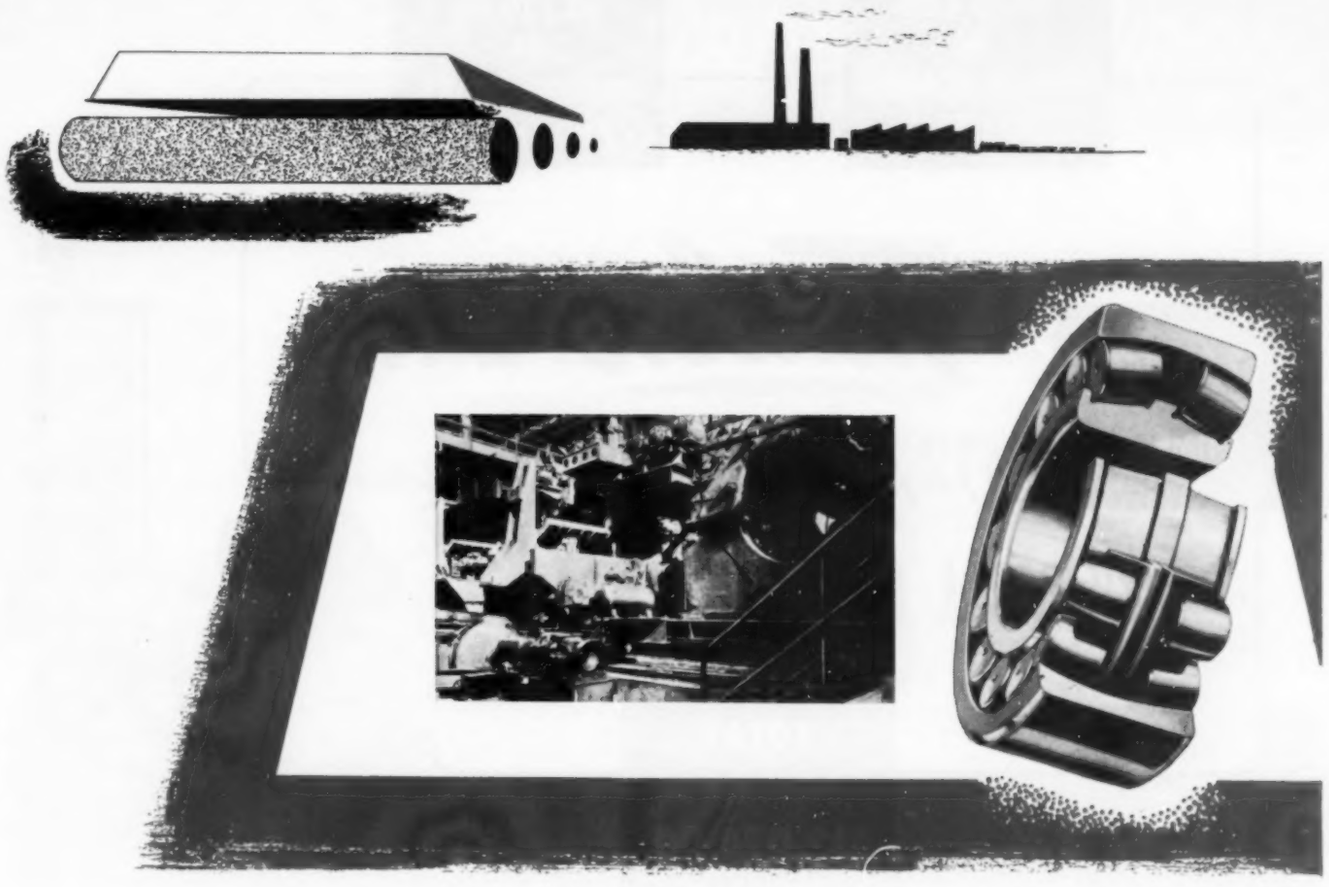

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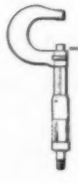

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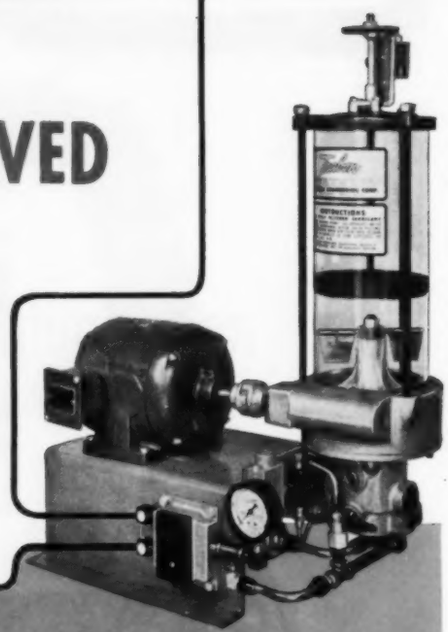

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Date-line Diary...

October 1

▲ The government finished the first quarter of the 1949-50 fiscal year which ended September 30th about $1,400,000,000 in the red.

▲ John L. Lewis ordered the hard coal miners and the soft coal miners west of the Mississippi back to the pits.

▲ Automobile production in September was 619,000 units for the third highest monthly production in history.

▲ Department of Commerce reported that unemployment dropped 338,000 from August to 3,351,000 in September. Total employment in September was 59,411,000.

▲ Steel production was shut down in the plants of all the major steel producers today as about 500,000 steel workers went on strike.

October 2

▲ The RFC paid out $2,800,000 of an authorized $6,350,000 to the Central Iron and Steel Co. The loan will be used partially to buy the physical assets of the Phoenix Bridge Corp., and the Phoenix Iron Works Corp. About $4,700,000 will be used by Central for a new blooming mill, soaking pits, heat treating furnaces, and to enlarge and modernize plant rolling equipment.

October 3

▲ Based on reports of companies having 94 per cent of the steel capacity of the industry, the operating rate of the steel industry is scheduled to be 8.2 per cent of capacity for the week beginning October 3, 1949. This is equivalent to 151,000 tons of steel ingots and castings compared with 1,559,600 tons one week ago.

▲ Department of Commerce reported that new construction put in place in September was estimated at $1,902,000,000. Private building construction in September increased which is contrary to the usual seasonal trend.

October 4

▲ Steel companies still operating are Weirton Steel Co., five plants of the Armco Steel Corp., Allegheny Ludlum Steel Corp., Kaiser Steel Corp., Portsmouth Steel Co., Edgewater Steel Co., John A. Roebling Sons Co., Granite City Steel Co., Struthers Iron and Steel Co., Timken Roller Bearing Co., Empire Steel Co., Alan Wood Steel Co., Carpenter Steel Co., Jessop Steel Co., McLouth Steel Corp., Pittsburgh Coke and Chemical Co., Wisconsin Steel Works, Texas Steel Co., Lone Star Steel Co., and Crucible Steel Co.

▲ Zinc prices dropped ¾¢ to a new price of 9¼¢ at East St. Louis. Lead dropped ½¢ to 14¼¢ per pound.

October 5

▲ The Kaiser Steel Corp. agreed on a new contract with the steel workers which is substantially in accord with the recommendations of the steel fact finding board.

October 6

▲ The total payroll for the first eight months of 1949 in the iron and steel industry was $1,496,980,000 or $69,000,000 greater than in the corresponding period in 1948. Total number of employees in August was 603,100, a decline of 6500 from July. Average payment to wage earners in August were $1.682 an hour compared with $1.699 in July, and $1.689 in August, 1948. Average hours per week in August were 36.5.

October 7

▲ The Aluminum Association reported that shipments of aluminum plate and strip increased for the first time in six months during the month of August. Shipments totaled 47,892,491 lb and production of primary aluminum totaled 104,009,815 lb during August.

▲ John L. Lewis met with the operators and Federal Mediator Ching in Washington today.

▲ AAR reported that work stoppages in the coal mines brought freight loadings down for the week ending October 1st to 658,128 cars or about 28 per cent below one year ago.

▲ The RFC granted the Kaiser-Frazer Corp. a $34,400,000 ten year 4 per cent loan.

October 8

▲ CIO Steel Workers set a strike deadline of October 27th for their employees working for the Aluminum Co. of America.

▲ Central Iron and Steel Co. granted their workers a contract substantially in agreement with the Fact Finding Board, and because of the increase in cost raised the price of steel plate $5.00 a ton to $75.00 a ton.

October 9

▲ The State Department reported that the United States had made tariff concessions on a variety of goods during talks held at Annecy, France.

October 10

▲ The American Railway Car Institute reported domestic freight car deliveries during September totaled 6141. September orders totaled 123 leaving a total backlog of 22,203 compared with 108,892 a year ago.

▲ Based on reports of companies having 94 per cent of capacity for the steel industry, the operating rate of the steel industry is scheduled at 9.3 per cent of capacity for the week beginning October 10, 1949. This is equivalent to 172,000 tons of steel ingots and castings for the entire industry compared with 151,000 tons one week ago.

October 11

▲ AISI reported that the steel industry consumed 97,659,000 tons of coal, 23,000,000,000 kwhr (42.1 per cent generated by steel companies themselves), 2,200,000,000 gal of fuel oil, 274,500,000,000 cu ft of natural gas and 296,325,000 gal of tar and pitch in 1948.

▲ American Iron and Steel Institute reported that total shipments of steel in the first six months of 1949 were 33,600,000 tons of which 5,900,000 tons went to the automotive industry, 4,100,000 tons to construction, 1,700,000 tons to machinery manufacturers, 2,500,000 tons to railroad transportation and 800,000 tons to appliance manufacturers.

▲ The Agriculture Department reported that the 1949 cotton crop was estimated at 15,446,000 bales for the largest in 12 years. The department also estimates that the 1949 corn crop will be 3,476,000,000 bu or the second largest crop in history.

October 12

▲ Shipments of refined copper in September rose to 103,115 tons.

▲ Kaiser Steel Corp. blew in a second blast furnace today named Bess No. 2.

October 13

▲ Electric power production fell below the corresponding figure of previous year for the first time in 1949 and the drop is attributed to the coal and steel strikes.

▲ The Commerce Department reported that inventories held by wholesalers increased $200,000,000 in August, retailers inventories increased $300,000,000 and manufacturers inventories were down $600,000,000 so that total inventories on August 31 were $50,400,000,000.

▲ The United Engineering and Foundry Co., Pittsburgh, purchased the Stedman Foundry & Machine Works, Inc., of Aurora, Ind. The company manufactures rolling mill machinery.

October 14

▲ John L. Lewis offered a settlement which would cost 30 to 35¢ per ton of coal and suggested that the government could take over the mines.

▲ Rail freight loadings dropped to 574,228 cars or 36 per cent below the like 1948 period.

▲ The Department of Commerce reported that personal incomes in August rose to an annual rate of $211,500,000,000.

▲ Lead prices in New York were reduced ¾¢ to 13¢ a lb.

October 15

▲ The F. W. Dodge Corp. reports that building and construction contracts awarded in September in the thirty-seven states east of the Rockies totaled $1,093,724,000 or the highest for any single month since June 1942.

October 16

▲ Secretary of Commerce Sawyer predicted that if the steel strike is continued until December 1st, it will cost the unemployment of 5,000,000 persons.

▲ Earnings of electric utilities in the third quarter of this year rose to a figure of $170,000,000. The biggest factor in increasing the net earnings was the decline in fuel costs and the more efficient generating equipment used.

▲ The Bureau of Labor Statistics reported that 100,000 homes and apartments were started in September for a new high for that month.

October 17

▲ Based on reports of companies having 94 per cent of capacity for the industry, the operating rate of the iron and steel industry is scheduled to be 9.3 per cent of capacity for the week beginning October 17, 1949. This is equivalent to 172,000 tons of steel ingots and castings compared with 172,000 tons one week ago.

October 18

▲ The Esso Standard Oil Company raised the price of No. 6 heavy fuel oil by 15¢ a bbl.

October 19

▲ The Youngstown Sheet and Tube Co., declared a $1.25 a share dividend on common stock payable December 15th.

▲ Following its settlement with the union, John A. Roebling Sons Co. increased the price of some strip and wire products $10.00 a ton.

October 20

▲ Ford Motor Co. announced plans for substantial cutbacks in production due to the steel and coal strike.

▲ The Armco Steel Corp. and the Armco Employee Independent Federation announced the settlement of a contributory social insurance program in which the company will pay 60 per cent.

▲ Jones and Laughlin Steel Corp. announced a salary cut of all salaried employees from 20 to 50 per cent depending upon the percentage of time the employee is working during the strike.

▲ According to Barron's Index, business volume throughout the country declined to 87.1 from 90.2 per cent in the previous week.

October 21

▲ Prices of scrap dropped $1.00 to $29.00 for No. 1 and to $27.00 for No. 2 heavy melting scrap in Pittsburgh, Pa.

▲ The ICC ordered a 25 per cent cut in operations of coal burning passenger locomotives on all railroads having less than a 25-day supply of coal.

October 22

▲ The General Motors Corp. is scheduled to go on a four day week beginning October 31st.

October 23

▲ Department of Commerce reports that companies' profits before taxes in the second quarter of this year were $6,600,000,000 which is 12 per cent below the first quarter and 25 per cent under the corresponding period of last year.

October 24

▲ The Labor Department reports that employment in industry and commerce hit the highest point for the year in the middle of September.

▲ Brehon Somervell, president of the Koppers Co., Inc., stated that they will build a plant at Port Arthur, Ontario to make pipe line coatings.

▲ The Portsmouth Steel Corp. has requested quotations from mill equipment manufacturers to cover facilities which will cost $10,000,000. Facilities will include continuous cold rolling equipment and pipe mill equipment, which will produce pipe ranging from 4 to 16 in.

▲ Based on reports of companies having 94 per cent steel capacity for the industry, the operating rate of the steel industry is scheduled at 9.0 per cent of capacity for the week beginning October 24, 1949. This is equivalent to 166,000 tons of steel compared with 172,000 tons one week ago.

October 25

▲ Prime Minister Attlee laid a program before the House of Commons which would cut 24 per cent from the 1949-50 budget. Dollar spending, defense costs and free medical services will be cut.

▲ The RFC reduced the price of tin 1¢ to 95¢ a lb.

▲ U. S. Steel Corp. reports income for the third quarter of $39,171,144 or $1.26 a common share compared with $1.08 for the corresponding period one year ago.

October 26

▲ The Jones and Laughlin Steel Corp. reported net income for the quarter ending September 30 of $4,870,019 or $1.73 a share. This compares with $8,757,416 or $3.39 a share for the same quarter in 1948.

▲ The American Institute of Steel Construction reported total shipments of fabricated steel in September of 151,346 tons and bookings were 118,187 tons. The backlog is 562,211 tons.

▲ The Labor Department reported that production workers in manufacturing industries were earning an average of $55.65 a week in mid-September.

▲ The E. W. Bliss Co., has received $1,300,000 worth of orders for rolling mills for Italy under the Marshall plan.

▲ Inland Steel Co. reported net income for the third quarter of $7,555,103 or $1.55 a share compared with $9,811,133 for the same quarter in 1948.

October 27

▲ Lake iron ore shipments so far this year totaled 68,133,373 tons compared with 70,707,682 tons one year ago.

▲ Westinghouse Electric Corp. reported net profits for the first nine months of 1949 were $3.64 a share which is a record for the period.

▲ The Reynolds Metals Co. announced an $8,000,000 expansion program in their Alabama operations which will include foil mills to operate at nearly a mile a minute, annealing ovens, and many high speed processing units.

October 28

▲ General Motors Corp. announced profits for the September quarter of $4.45 a common share which compares with $2.67 a share in September 1948. Sales for the first nine months rose to $4,458,000,000 compared with $3,436,000,000 for the same period the previous year.

▲ Eugene G. Grace, chairman Bethlehem Steel Corp., predicts that the U. S. may soon be forced out of the ocean shipbuilding and steel exporting business because of devaluation of foreign currencies, lower wages abroad, and creation of new steel capacities in other parts of the world.

▲ Bethlehem Steel Corp. announced net profits for the first nine months of 1949 of $8.14 a common share compared with $5.39 for the same period last year.

▲ The price of zinc was raised ¼¢ to 9½¢ a lb at East St. Louis.

▲ The Lukens Steel Co. cut pay of salaried workers 18 per cent for the duration of the strike.

▲ According to the Engineering News-Record, civil engineering construction contract awards for the week ending October 27 totaled $135,843,000 or 24 per cent below a year ago. Awards for the year to date totaled $6,724,618,000 which is up 16 per cent from one year ago.

▲ The National Steel Corp. reports net income for the quarter ending September 30 of $10,047,905 or $4.09 a share compared with $5.01 a share in 1948.

▲ Youngstown Sheet and Tube Co. reported a net income for the third quarter of $7,514,626 or 16½ per cent below the second and 37½ per cent below the earnings for the first quarter.

▲ The Lone Star Steel Co. announced that its new steel plant will cost about $52,500,000 and will include four 188-ton open hearth furnaces, a 110-in. slabbing mill, one 72-in. reversing hot strip mill and an electric weld pipe mill with a capacity of 350,000 tons a year of pipe up to 16 in. in diameter.

▲ The Armco Steel Corp.'s new $12,000,000 open hearth plant at Middletown, Ohio will consist of three 225-ton open hearth furnaces. This is the beginning of a $100,000,000 expansion program.

October 29

▲ The Federal Reserve Board estimates industrial output in October will be nearly 12 per cent below September.

▲ According to the Bureau of Labor Statistics, food and fuel prices led in a rise of 0.5 per cent in the consumer price index which rose to 169.6 per cent on September 15th.

October 30

▲ The Armco Steel Corp. announced earnings of $6,584,411 or $1.63 per share for the third quarter of 1949. This compares with $2.09 per share one year ago.

▲ The Bureau of Mines announced that the marketed production of natural gas in 1948 rose to 5,148,020,000,000 cu ft for an increase of 12 per cent over 1947. The value of all natural gas used in 1948 at points of consumption was $1,193,529,000. Gas for domestic and commercial use had an average unit value of 59.6¢ per 1000 cu ft.

October 31

▲ Based on reports of companies having 94 per cent of the steel capacity for the industry, the operating rate of the steel industry is scheduled to be 8.8 per cent of capacity for the week beginning October 31. This is equivalent to 162,000 tons compared with 166,000 tons a week ago.

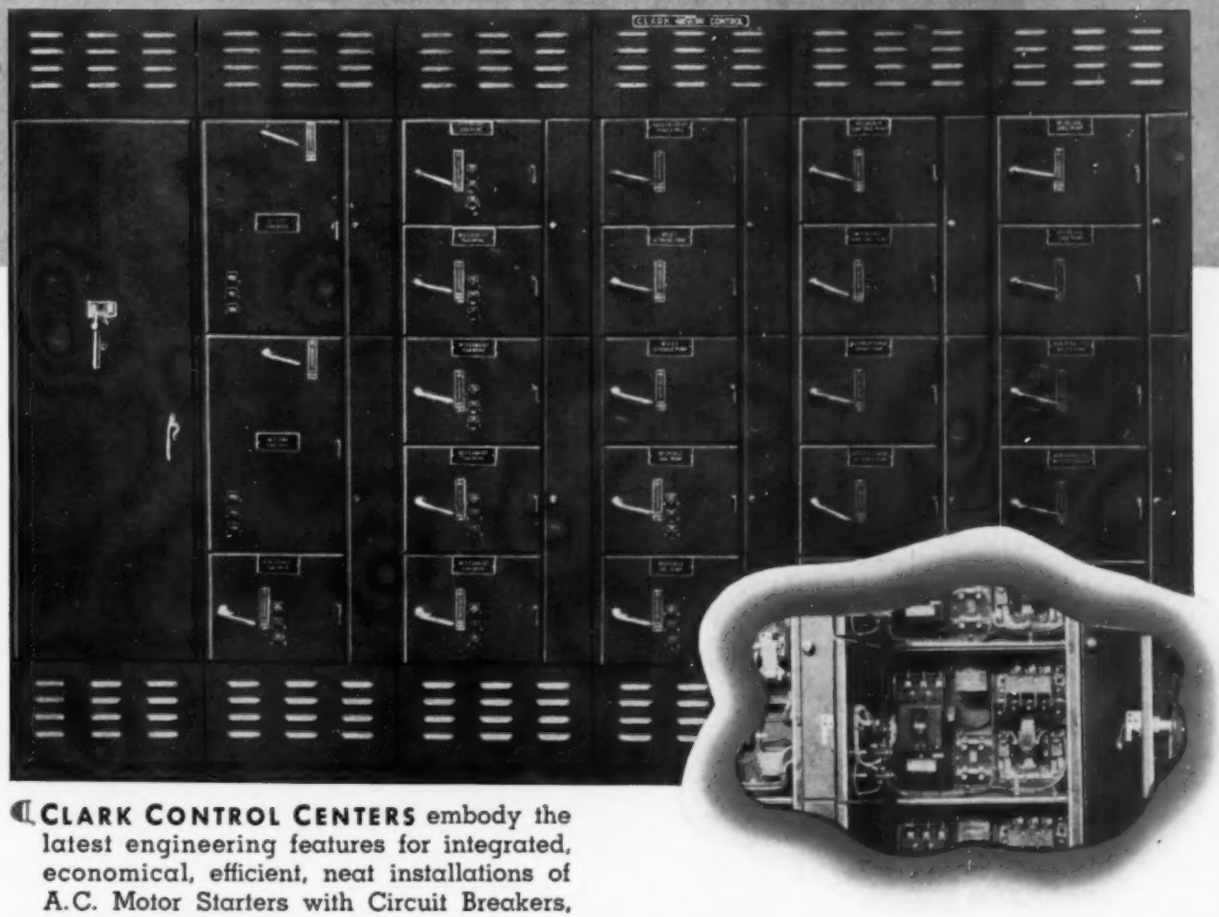
▲ The Bethlehem Steel Corp. signed an agreement with the CIO Steel Workers for the first major break in the steel strike. The plan provides for contributory social insurance and non-contributory pensions. Bethlehem's total cost is estimated at 12½¢ per hour per worker which is several cents higher than the 10¢ an hour recommended by the Steel Fact Finding Board. The union on the other hand withdrew its insistence that the steel producers pay the entire cost of the welfare benefits.

▲ A new all-time world's record of steel produced by twelve stationary open hearth furnaces for a single month was set in October by the Weirton Steel Co. with an output of 200,379 tons of ingots.

Presenting . . .

CLARK CONTROL CENTERS

New! Modern! Efficient!



¶ **CLARK CONTROL CENTERS** embody the latest engineering features for integrated, economical, efficient, neat installations of A.C. Motor Starters with Circuit Breakers, or Fusible Disconnect.

¶ Each section is 90" high, 24" wide, and 20" deep, and all sections can be arranged in any angular pattern to meet floor space requirements. Additions to existing installations are easily made.

¶ The 24" width has the definite advantage of supplying liberal wiring space for all units. For starters up to and including Size 3, a 6" wiring trough with hinged door is provided.

¶ Units are 13" high, or a multiple thereof. Each section accommodates any combination of starters (Sizes 1 through 5) totalling 65" in height. Rearrangements are easily made at any time.

Close-up view of Size 2 Starter and Circuit Breaker.

¶ Louvres, top and bottom, provide adequate ventilation, and avoid accumulative heating.

¶ Units are "plug-in" type, easily removed.

¶ Load and control leads, and horizontal line bus can be placed in either the top or bottom and can be interchanged.

¶ The control equipment and wiring troughs are accessible from the front, by simply opening a door.

¶ Vertical sections are mounted on a common floor channel for rigidity and perfect alignment.

For full details ask for Bulletin 6200

ENGINEERED ELECTRICAL CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET, CLEVELAND 10, OHIO

Is UPKEEP COST your magnet problem?

Although it looks and lifts like new, this Ohio Magnet is actually 22 years old. Until recently, upkeep cost was zero. Then a ground developed in the terminal box and the magnet was shipped to our plant, where repairs were quickly completed without disassembly.

Upkeep cost? Under $100—*less than $5 a year for 22 years!*

Next time you buy a lifting magnet, remember that heavier construction assures extra years of low-cost life. Send your order to Ohio—*25 years a leader in magnetic materials handling.*

This magnet averaged less than $5 a year!

OHIO PROTECTO-WELD MAGNET is welded *on top,* where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

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ohio MAGNETS

A-2012

Industry News...

REYNOLDS METALS TO BUILD ALUMINUM ROLLING MILLS IN ALABAMA

▲ Reynolds Metals Co. has launched an $8,000,000 expansion program in its Alabama operations which, when completed, will increase its number of employees in the area by several thousand men and will give the company the most complete, diversified aluminum manufacturing unit in the world.

Construction and installations under the expansion program are under way at the huge Reynolds Alloys Co. plant at Listerhill, Ala.

The expansion includes the installation of new Lewis foil mills which operate at a speed of nearly a mile a minute; General Electric annealing ovens and many modern high speed processing units; two new aluminum-covered buildings giving an additional 200,000 sq ft of floor space; a large cable plant for greatly increased production of aluminum cable steel reinforced for electric conductor; additional rod rolling facilities some of which were transferred from a Reynolds Metals plant in Louisville, Ky.

The new foil rolling facilities being installed will give Reynolds one of the most efficient foil plants in the world. The new rolling mills will allow Reynolds for the first time to produce much wider foil in one operation.

The largest of the new buildings will house the cable plant which includes new cable mills and twenty new stranding machines. These stranders can turn out the ACSR cable at the rate of 1000 miles a day. Reynolds signed a contract in January to supply cable for rural electrification over a 15-year period. The enlarged cable manufacturing facilities were put into the plan to fill the 15-year contract.

A number of the new foil mills already are in production. Several of the cable stranders are in production at temporary locations, until the new building is completed. All expansion work is scheduled for completion by January 1, 1950. When this takes place, the manufacturing set-up at Listerhill will be so arranged that alumina will be put into the Reynolds Metals plant on one side of the vast outlay, processed into aluminum metal, brought on rails over to the adjacent Reynolds Alloys plant, made into aluminum alloys, and then sent on its long journey down the line through mills and presses, becoming sheet, foil, cable, wire, rod, angles, channels and many other aluminum products ready for shipment to all parts of the globe.

The Reynolds properties at Listerhill represent the largest private industrial investment with the largest private enterprise payroll in this section of the South.

INDUSTRIAL FURNACE FIRM IS ORGANIZED

▲ Creation of a new associated company, Affiliated Furnace & Engineer-

TANK DESIGN REDUCES SHELL PLATE SCRAP

Spherical tanks are economical for pressure storage because that shape most effectively resists internal pressure and because the area of shell per unit of volume is less than that of any other shape. The use of spherical tanks has been restricted because of the rather large amount of scrap or waste material involved in their fabrication from rectangular plates.

Illustrated in the photograph is a completed icosasphere. This sphere is 32 ft 5 in. inside diameter and is made up of only twenty, ½ in. shell plates supported on five columns. The icosasphere is designed and constructed by the Pittsburgh-Des Moines Steel Co. who hold the patents on this design. The advantages of this unit over conventional designs such as the orange peel is that the individual plates approximate very closely rectangular sections and thus scrap loss is kept at a minimum. In addition this type of construction also results in a minimum total length of seam which reduces the welding cost appreciably. The resultant savings give this type of construction a definite cost advantage. The method of design is also applicable to spherical, spheroidal and ellipsoidal tanks as well as to elevated tank bottoms and roofs. One of the interesting problems in the design has been the method developed to improve the plate layout of a double curved surface since it is necessary to be able to predict the size and shape of a flat plate which after dishing will form a specified portion of the double curved surface. By making layout studies with thin sheet plastic models, the information resulting from these studies gives the data needed to dish the actual tanks.

Recirculating Radiant Tube

ANNEALING FURNACES

One of many fine-performance features: the unique Swindell-Dressler *high velocity* burner, which gives better, more uniform distribution of heat in the tube . . . and very exceptional tube life with coke oven gases (2 to 3 times normal). *May we consult on your needs?*

SWINDELL-DRESSLER *Corporation*

Designers and Builders of Modern Industrial Furnaces

PITTSBURGH 30, PENNA.

ing, Inc., has been announced by Charles E. Stone, president of Chemsteel Construction Co., Inc., Pittsburgh, Pa.

The new affiliate will specialize in design, construction and maintenance of industrial furnaces. Offices will be maintained with Chemsteel at 5428 Walnut Street in Pittsburgh, Pa. Officers are: Arthur M. Krieger, president and general manager; Clarence B. Avery, vice president, engineering; Merrill A. Stewart, vice president, construction; and Charles E. Stone, secretary-treasurer.

APPOINT REPRESENTATIVES IN WESTERN STATES

▲ Delta-Star Electric Co., Chicago, has recently appointed A. J. Elggren & Sons Co., 428 South West Temple Street, Salt Lake City 13, Utah, as district representative for the states of Idaho and Utah. John E. Elggren, engineer, will personally cover field contacts while A. Lewis Elggren, office manager, will handle direct calls.

COLD STRIP DEPARTMENT RECEIVES SAFETY PLAQUE

▲ Cold strip department at the Campbell plant of the Youngstown Sheet & Tube Co. recently received a bronze plaque for operating more than one million man hours without a disabling injury.

The plaque was presented to C. J. Daley, superintendent, by J. S. Stanier, general superintendent.

The record began in November, 1949 and was completed August 1, 1949. During that period the department produced 425,134 tons of steel, enough to make 500,000 average automobiles.

This is the first million man-hour plaque won by cold strip department since it began operating in 1935.

BETHLEHEM AND REPUBLIC SHARE 5 OF NINE AWARDS

▲ Bethlehem Steel Co. and Republic Steel Corp. today shared five of the nine awards to steel mills, traditional leaders in safety among heavy industries, in the metals section contest conducted annually by the National Safety Council.

The awards were made October 26 in Chicago, Ill., at the 37th National

For a maximum of long, efficient, trouble-free service

● Quick-As-Wink Valves are high quality controls designed and built to meet the most exacting requirements. All operating parts are in pressure balance eliminating any tendency to creep or crawl. The U-shaped packers are expanded by pressure and seal tightly preventing leakage. There is no lapping — no grinding — no metal-to-metal seating. Every valve is precision made and individually tested to its full pressure rating before being shipped.

Furnished in hand, foot, pilot, solenoid and diaphragm operated designs for controlling all types of air and hydraulic equipment. Let us work with you on your requirements!

Quick-As-Wink Lever Operated Hydraulic Valves

The HS-551-N4 pictured above is a neutral position 4-way valve for controlling double acting cylinders. It has a machined steel housing, chrome plated and polished stainless steel plungers, and renewable metal rings to take the impingement of the liquid flow preventing wear on the U-packers. Used for oil or water up to 3500 P.S.I. and 150° F. Other valves available for pressures up to 5000 P.S.I.;— but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

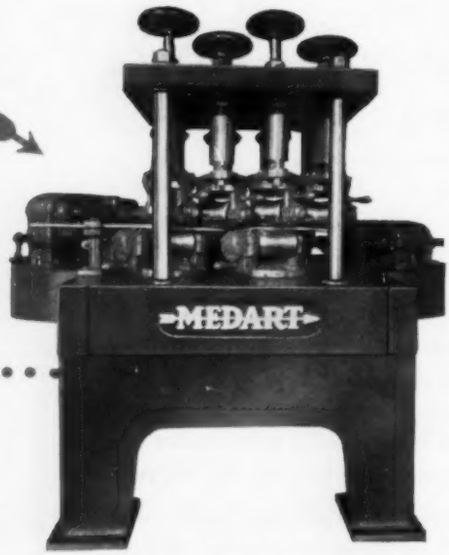
Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

MEDART MICRO-MULTICYCLE!

straightening machine designed exclusively for ⅛" to ½" bars and tubing.

Small, compact yet built on the same principle and embodying the same advantages as the Medart 6-in-1 Multicycle Straightener . . . positive, synchronized feed . . . one feeding level . . . two bending cycles . . . single motor . . . and the Medart Micro-multicycle has this PLUS FEATURE: all six rolls are driven! A variable feed-speed range is built into the machine. 3 H. P. motor mounted on base of machine.



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY • 3500 DE KALB ST., ST. LOUIS, MO.

Safety Congress, annual convention of the Council.

Bethlehem swept the first three awards for largest mills in the year-long contest, the Johnstown, Lackawanna and Bethlehem mills finishing in that order.

Republic's Canton mill took first in the next size group, while the Gulfsteel Works of the company finished third. National Tube won second place.

Among the smaller mills, the first three awards were won respectively by American Steel & Wire, Copperweld Steel, and Follansbee Steel.

Other safety awards were made in eight additional classifications, including rolling mills, non-ferrous metals and products, foundries, machine shops with foundries, heavy fabricating, light fabricating, heavy machinery and light machinery.

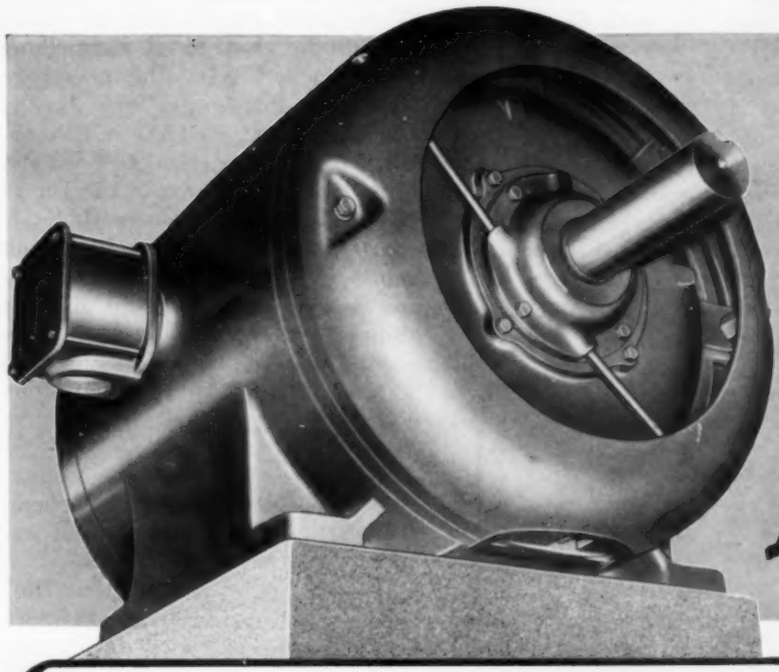
For the twelve months, the steel industry as a whole had a frequency rate of fewer than six accidents for each million man-hours of work. This was the fourth consecutive year in which the industry had an actual reduction in accidents among its personnel, and the accident trend has been steadily downward for 20 years. The record again put steel at the head of all heavy industries, and fourth among all industries, according to Council records.

PIPE CLEANING FIRM FORMS CALIFORNIA UNIT

▲ Pittsburgh Pipe Cleaner Co. has announced the organization of a subsidiary company, Pittsburgh Pipe Cleaner Co. of California, with offices at 119 New Montgomery Street, San Francisco 5, Calif. Fred C. Morris is the manager of this new subsidiary.

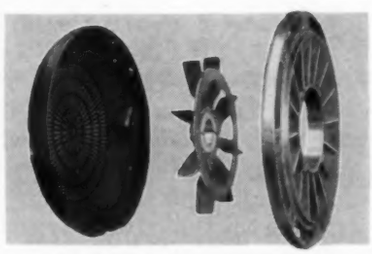
UNITED ENGINEERING ADDS TWO SUBSIDIARY FIRMS

▲ Signing of the sale contract on October 12, 1949, at the Central Trust Co. in Cincinnati, Ohio, transferred the Stedman Foundry and Machine Works, Aurora, Ind. to the United Engineering and Foundry Co., Pittsburgh, Pa. The stock transfer and the sale of the Stedman Foundry and Machine Works involve approximately one million dollars, according to K. C. Gardner, president and chairman of the executive committee of the United Engineering and

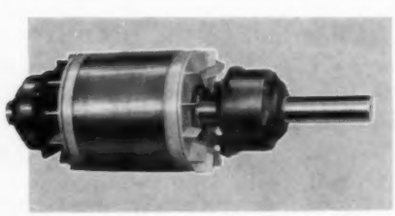


Wagner
Totally-Enclosed Fan-Cooled Motors
Built for your Protection

here's the Inside Story!



Fan shield, which protects externally mounted, non-ferrous ventilating fan; and front endplate, ribbed for mechanical strength.



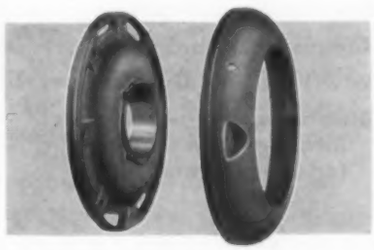
Cast aluminum rotor with cartridge-type ball bearings.

Wagner totally-enclosed, fan-cooled motors are designed for a particular purpose—to operate efficiently and safely in atmospheres filled with dust, fumes, moisture, explosive gases and combustible substances. These motors are approved by Underwriters' Laboratories for Class I Group D and Class II Groups E, F, and G hazardous locations. The photographs indicate the painstaking care with which these motors are built for your protection. They are available in ratings up to 200 horsepower, and are varied electrically to suit a wide variety of application requirements. Bulletin MU-185 gives information on the complete line of Wagner Motors.

BUYERS OF WAGNER MOTORS GET NATIONWIDE SERVICE! More than 450 Wagner Authorized Electrical Service Stations and Parts Distributors augmented by 25 Wagner-owned Service Branches are ready to immediately supply on-the-spot service, factory guaranteed exchange motors, or genuine Wagner parts. Write for Bulletin MU-24 for complete list.

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Mo., U. S. A.

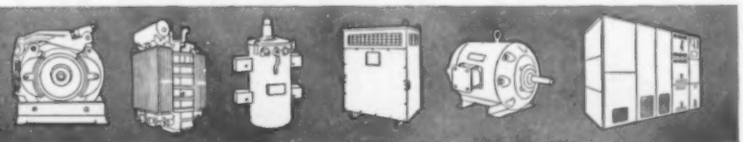
Wound stator, showing extra large air ducts.



Back endplate, and shield which directs ventilating air so that it cools the drive-end bearing.

Consult Wagner Engineers on all Electric Motor Problems

Wagner Electric Corporation
EST. WE 1891



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ELECTRICAL EQUIPMENT AND AUTOMOTIVE BRAKE PRODUCTS

M49-7

Foundry Co., also named chairman of the board of the new Aurora company under its new ownership.

The Stedman Foundry and Machine Works, 115-year old Aurora, Ind., industry, employs approximately 200 persons. The plant has two divisions: (1) The foundry division, which specializes in gray iron and semi-steel castings; (2) The machinery section, which makes crushing, grinding, pulverizing, and screening machinery.

In addition to K. C. Gardner, president of United, who was named chairman of the board of the company under the new ownership, other officers named were: G. G. Beard of Pittsburgh, Pa., president; G. V. Lang of Pittsburgh, Pa., treasurer; A. E. Schneider of Cincinnati, Ohio, vice president and general manager; and Lester Etter of Aurora, Ind., secretary and assistant treasurer. Mr. Beard is executive vice president and Mr. Lang is treasurer of the United Engineering and Foundry Co. Mr. Schneider had been vice president in charge of sales and Mr. Etter was comptroller of the Aurora company under its former ownership.

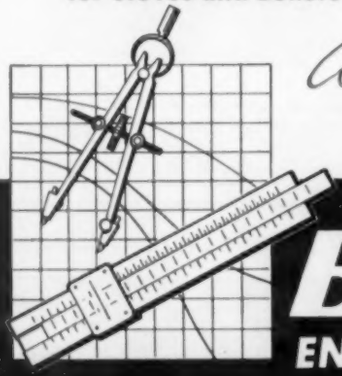
BLOOM

ENGINEERED COMBUSTION EQUIPMENT

for Steel Mills and Industrial Furnaces

Bloom Engineering Company designs and manufactures combustion equipment for steel mill and industrial furnaces. The correct application of these products is an important part of our service to customers.

- Long Flame Gas Burners
- Hot Air Burners
- High Pressure Fuel Oil Burners
- Nozzle Mix Burners
- Tempered Flame Burners
- Raw Producer Gas Burners
- Bloom-Paulsen-Steinbart Blast Furnace Gas Burner for Stoves and Boilers
- Low Btu Gas Burners for Galusha Producer Gas, Blast Furnace Gas, Mixed Gases
- Differential Pressure Constant-Flow Oil Valves
- Steam-Oil Pressure Ratio Regulator
- Bloom Time Cycle Reversal Systems for Open Hearth Furnaces



Write for bulletins on any of the above Bloom Equipment.

BLOOM ENGINEERING CO., INC.

857 W. North Avenue Pittsburgh 12, Pa.

Stedman Foundry and Machine Works is the seventh company owned outright by the United Engineering and Foundry Co. Its other plants are located at Pittsburgh, New Castle, and Vandergrift, Pa.; Akron, Canton, and Youngstown, Ohio. In addition, United is a part-owner of the Davy-United Engineering Co. with headquarters in Sheffield, England, and plants in Middleborough, England, and Glasgow, Scotland. United is affiliated with the Dominion Engineering Co., Montreal, Canada, and Societe l'Etude et la Construction d'Installations Metallurgiques in France.

The United Engineering and Foundry Co. is a combination of several other and much older firms and was incorporated on July 1, 1901.

Lobdell Co. of Wilmington, Del., and United Engineering and Foundry Co. of Pittsburgh, Pa., also announce that certain assets of Lobdell Co., including the plant, land, buildings and equipment comprising the machine shops of Lobdell Co., are being acquired by a wholly owned subsidiary of United Engineering and Foundry Co. named Lobdell United Co. Lobdell United Co. will, as of November 1, 1949, take over and continue to operate the Lobdell plant, which manufactures paper mill machinery, calender stacks, paper and steel mill roll grinders, and Nazel forging hammers.

Lobdell United is the eighth company owned outright by the United Engineering and Foundry Co. Its other plants are located at Pittsburgh, New Castle, and Vandergrift, Pa.; Akron, Canton, and Youngstown, Ohio; and Aurora, Ind.

BUILD NEW PIPE MILL AT HOUSTON, TEXAS

▲ Houston, Tex., has been chosen as the site for a new electric welded steel pipe mill to be built by the Consolidated Western Steel Corp., it was announced recently by Alden G. Roach, president of this United States Steel subsidiary.

Preliminary construction work has begun on property owned by Consolidated Western near the Houston Ship Channel. It is expected that the new plant will be in operation in the spring of 1950.

The new facilities will provide an annual capacity of 100,000 net tons

DRAW PULL: 725 feet per minute!

TORRINGTON WIRE DRAWING BLOCK
on the job in Detroit, Michigan

- Designed for high production wire drawing
- Requires minimum time for threading up and removing finished coils
- All controls placed convenient to operator
- Worm gear drive for smooth operation • Safety loop
- Adjustable speed control allows slow start and smooth acceleration to maximum operating speed
- Stops automatically if wire breaks or tangles, to allow for operation of safety loop
- Counterbalanced self-aligning die holder arranged to carry die close to draw ring; permits use of short point on wire
- Hand wheel permits orienting grip to proper position by hand at start of draw
- Guard block protects operator from flying end of wire; and is quickly opened for access to block
- Completed coil drops to table below block, where it is held in location by pins which can be withdrawn under air power for removing the coil from the machine
- Available in several sizes, with draw pull up to 11,000 pounds

FOR OVER 60 YEARS *Torrington Manufacturing Company has been designing and building machinery for processing sheet, strip, flat wire, rods and tubes.*

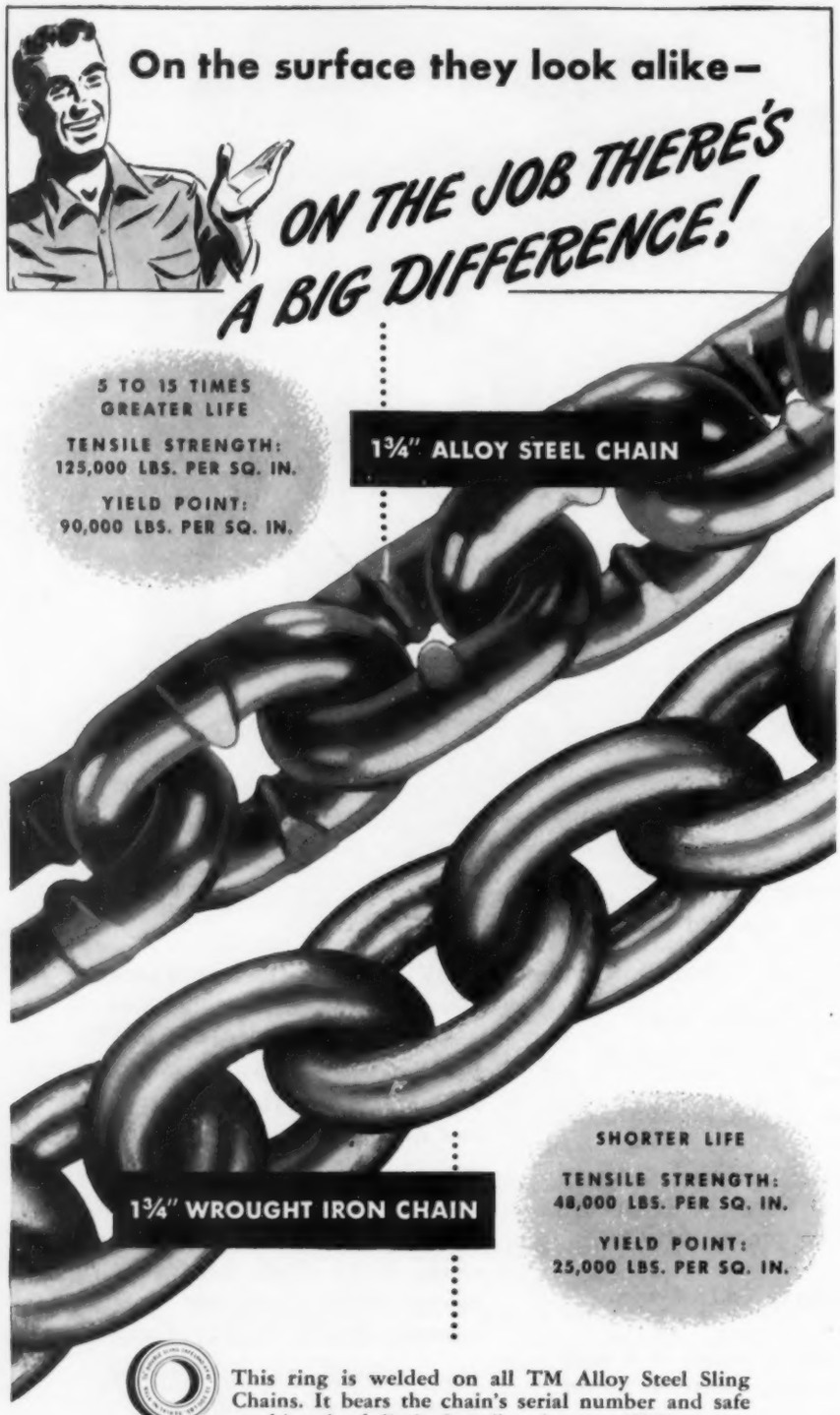
Efficient, modern facilities include a highly trained design and engineering staff, pattern shop, forge shop, hardening room, welding shop, and large assembly floor covered by cranes.

Here, experienced, skillful men work under ideal conditions.

Call or write Torrington today for more information and name of nearest Torrington representative.

The **TORRINGTON**
MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT

DESIGNERS AND BUILDERS OF MILL MACHINERY FOR OVER 60 YEARS


On the surface they look alike—
ON THE JOB THERE'S A BIG DIFFERENCE!
5 TO 15 TIMES GREATER LIFE
TENSILE STRENGTH: 125,000 LBS. PER SQ. IN.
YIELD POINT: 90,000 LBS. PER SQ. IN.
1¾" ALLOY STEEL CHAIN
1¾" WROUGHT IRON CHAIN
SHORTER LIFE
TENSILE STRENGTH: 48,000 LBS. PER SQ. IN.
YIELD POINT: 25,000 LBS. PER SQ. IN.

This ring is welded on all TM Alloy Steel Sling Chains. It bears the chain's serial number and safe working load limit. In effect it says: "When your lifting requirements are big and your present chain performance leaves something to be desired—it's time to switch to TM Alloy Steel Chain." It's tougher... safer and far more economical than ordinary wrought iron chain. Used by steel, automotive, petroleum, marine and manufacturing industries generally, because *comparison, experience and costs proved its superiority.* For all the facts, write today for free copy of new booklet; "TM Alloy Steel Chain". The S. G. Taylor Chain Company, 62-141st St., Hammond, Indiana.

See your Mill Supply Distributor or send today for free copy of new TM Alloy Steel Chain Booklet!

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

of 24 in. diameter and larger electric welded and expanded steel pipe, and will enable Consolidated Western Steel Corp. to compete in the Texas area, and particularly in the market for large diameter pipe required for long distance oil and gas pipe lines.

At present United States Steel has no facilities for the production of this type of pipe east of the Rocky Mountains or south of the Pittsburgh, Pa., area.

"In the selection of Houston as the location for its new mill, Consolidated Western Steel Corp. is carrying out a plan to provide Texas fabricated pipe to the growing network of oil and gas transmission lines originating in the Lone Star State," Mr. Roach said.

"Consolidated Steel has played a part in the industrial development of Texas for many years, particularly at Orange. I am happy and proud to announce that our new plant at Houston and our modernized facilities at Orange will enable us to contribute further to the growing productive strength of this great state."

FRENCH STRIP MILL BUYS SKF SPHERICAL BEARINGS

▲ SKF Industries, Inc., recently announced receipt of an order for 23 tons of anti-friction bearings to be installed in a hot strip mill in the heart of France's Lorraine iron ore basin.

The order was placed by United Engineering & Foundry Co. of Pittsburgh, which will construct the mill for the Societe Lorraine de Laminage Continu (Sollac). It calls for 76 spherical roller bearings weighing a total of 45,756 lb for the mill's drives and pinion stands.

The Philadelphia firm regularly supplies spherical roller bearings to most of the nation's steel and aluminum mills.

The bearings destined for France range in size from two to three feet in diameter and weigh from 459 to 1342 lb apiece. The largest bearing has a catalog load rating of 1,290,000 lb at a speed of 33⅓ rpm.

SKF engineers said the 55,250 hp required to operate the continuous mill and transmitted through the roller bearing-supported drives and pinion stands is sufficient to supply the electric power needs of a city of 75,000 population.

Personnel News...

Robert W. Wolcott, president of Lukens Steel Co. since 1925, was named chairman of the board, and **Charles Lukens Huston, Jr.,** vice president and executive assistant to the president since February 1948 was elected president of the company by action of the board of directors at its recent meeting. Mr. Wolcott, a native of Sewickley, Pa., and an alumnus of Lehigh University, has been associated with Lukens since 1922, serving first as manager of its warehouse and fabricating division in New Orleans. He became president of the company in 1925 and has held that position ever since. During World War I, Mr. Wolcott served as a lieutenant-commander in the naval aviation service. During World War II, he served as a member of the industry advisory committee, iron and steel division, War Production Board and as a consultant, steel division, War Production Board.

Mr. Huston, a lineal descendant of Isaac Pennock, a founder of the business in 1810, became associated with Lukens in 1939, after 10 years with Armco Steel Corp., Middletown, Ohio. A native of Coatesville, he was graduated from Princeton University in 1928, and the following year took graduate work at Massachusetts Institute of Technology. He joined Lukens as a director of personnel relations, subsequently becoming president of Lukenweld, Machinery-making division of Lukens. In 1946, he became executive assistant to the president of Lukens, when Lukenweld and By-Products subsidiaries ceased their corporate existence and were absorbed into the parent company. In 1948, he was elected vice president of Lukens.

Harold R. Ryan has been transferred back to the Youngstown district as superintendent of the Brier Hill open hearth department of Youngstown Sheet and Tube Co. He succeeds **Paul Johnson** who recently left the company. Mr. Ryan, a native of Lorain, Ohio, attended public schools there, then went to Ohio State University where he received a metallurgical degree. He began working as a pipe tester for National Tube Co. in Lorain at the age of 17, while going to school. After completing his college work, he served as an open hearth observer for National Tube. Mr. Ryan joined Youngstown Sheet and Tube Co. April 3, 1937 as an observer foreman in the Brier Hill metallurgical department. Two and a half years later he was appointed first helper in the open hearth department, became a melter in June, 1941, and a practice engineer in Brier Hill open hearth in February, 1947. On September 1, 1947, Mr. Ryan was transferred to the Indiana Harbor plant, Chicago district, as assistant superintendent of the open hearth department.

Elmer H. Riddle has been appointed superintendent, blast furnace department at the Aliquippa, Pa., works of Jones and Laughlin Steel Corp. Mr. Riddle was formerly assistant superintendent. He has been associated with the blast furnace department for the past 22 years.

W. Francis Scanlan has been appointed superintendent of maintenance of the steel division of the Alan Wood Steel Co., Conshohocken, Pa.

Harry A. Erb has rejoined the Elliott Co. as assistant to the vice president in charge of engineering, with headquarters at the main plant of the company at Jeannette, Pa. Mr. Erb came with the Elliott Co. out of Cornell University in 1928. He served as blower engineer, manager of the service department and manager of the electric power department of Elliott Co.'s Ridgway, Pa., division. For the past six years he has been steam turbine department service manager for Worthington.

Robert A. Speck and **George R. Milne** have been appointed vice presidents of National Carbide Corp., New York, N. Y.; Mr. Speck in charge of sales and distribution, Mr. Milne in charge of operations.

Arthur Kuiper was elected treasurer of Continental Foundry and Machine Co., East Chicago, Ind. Mr. Kuiper was formerly controller, and succeeds **W. L. Spencer** who has retired.

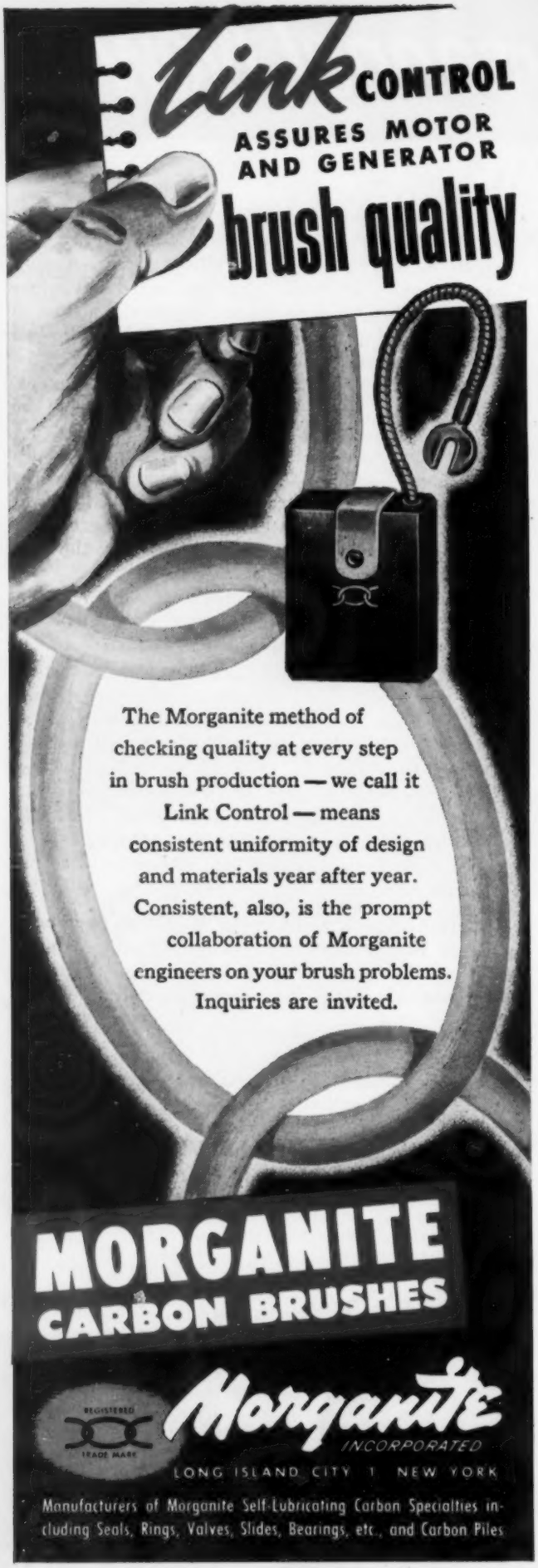
Ray H. Timmons has recently been appointed manufacturing manager of industrial products for the Westinghouse Electric Corp. In his new position, Mr. Timmons will have broad staff responsibility for super-

ROBERT W. WOLCOTT

C. L. HUSTON, JR.

HAROLD R. RYAN

ELMER H. RIDDLE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ASSURES MOTOR AND GENERATOR
brush quality
The Morganite method of checking quality at every step in brush production — we call it Link Control — means consistent uniformity of design and materials year after year. Consistent, also, is the prompt collaboration of Morganite engineers on your brush problems. Inquiries are invited.
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Manufacturers of Morganite Self-Lubricating Carbon Specialties including Seals, Rings, Valves, Slides, Bearings, etc., and Carbon Piles

vising and coordinating manufacturing of a wide range of industrial products such as meters, transformers, motors, and generators. Mr. Timmons formerly was manager of manufacturing for the company's transportation and generator division at East Pittsburgh, Pa.

C. H. Hosterman, for many years manager of the accessories department for Elliott Co., Jeannette, Pa., was appointed manager of the general apparatus department. This department now handles sales of the accessories, heater, condenser, and ejector divisions. Mr. Hosterman went to Elliott Co. from Pennsylvania State College in 1922.

Cecil Roy Pond was appointed as sales representative in Birmingham, Ala., for the Automatic Transportation Co., Chicago, Ill. His territory will include Alabama, and the northwestern part of Florida. Headquarters are at 625 Comer Building, Birmingham.

John W. Miller was appointed superintendent of production planning at Kaiser Steel Corp., Fontana, Calif., succeeding **Tom Jones,** who resigned. Mr. Miller came to the Kaiser plant January 1, 1945, as assistant superintendent of production planning, and rose rapidly

JOHN W. MILLER

through administrative posts to become assistant to the general superintendent. Previously he had held various managerial posts for 12 years at the South Chicago plant of Carnegie-Illinois Steel, including the position of assistant superintendent of production planning.

W. C. Chapman was appointed senior field superintendent of the Freyn Engineering Co., Chicago, Ill. **Robert K. Matthews** has been advanced to the post of general construction superintendent while **Russell A. Powell** assumes the responsibilities of assistant chief engineer. A 1931 graduate of Purdue University, Mr. Chapman at present is in charge of construction of a sintering plant for the Carnegie-Illinois Steel Corp. at Gary, Ind. Prior to joining Freyn in 1940, he worked on strip mill construction for the Jones & Laughlin Steel Corp. at Pittsburgh and the Inland Steel Co. at Indiana Harbor, Ind., as well as on strip mill and open hearth construction for the Youngstown Sheet & Tube Co. at Indiana Harbor. Mr. Matthews, a graduate of the University of Colorado, spent six years in municipal construction work followed by three years in steel plant engineering and construction before joining Freyn in 1943. A graduate of Rose Polytechnic Institute, Mr.

16-ton

Hardtem Die Blocks by Heppenstall

These Heppenstall Die Blocks—the largest and heaviest we ever forged—are 16 inches thick, 44 inches wide, and over 13 feet long. Each block weighs approximately 32,100 pounds.

Because we specialize in the manufacture of die blocks, developing our steel making and forging skill over a span of 63 years, we succeeded in fabricating these huge blocks to exact specifications.

In every Heppenstall Die Block, you can be sure of ultimate quality because *quality* is our watchword . . . from the selection of raw materials, through our open hearth, forging and heat treating operations . . . to the final inspection of each die block with the supersonic reflectoscope.

Whatever your die block requirements are, you can rely upon Heppenstall Die Blocks for a substantial margin of extra service. Heppenstall Company, Pittsburgh 1, Pa.

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1869 1949

FOR HARD FACING AND REPAIR

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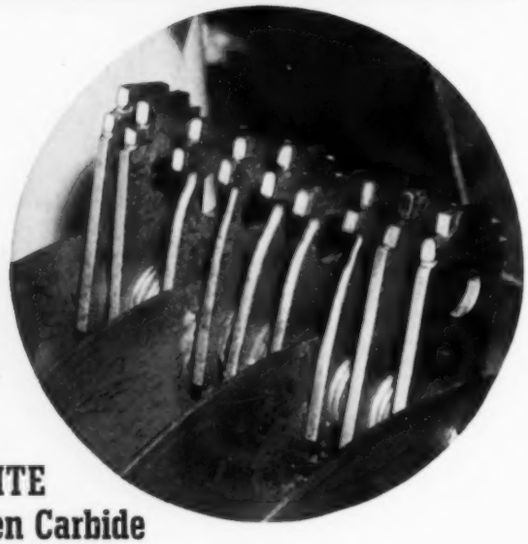
WELDING PRODUCTS



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INSERTS

FOUR WEEKS—*instead of only four days*—now that these hammers are tipped with Amsco Tungsite Inserts! Imagine how this 500% longer hammer life, with its reduction in machine repair and down time, has cut the costs of pulverizing asphalt roofing trimmings.

Amsco Tungsten Carbide welding products are available as Inserts . . . or as Tungrod and Tube Tungsite hardfacing rods and electrodes. To meet all job needs . . . Inserts are available in a wide range of shapes and sizes . . . and Tungrod and Tube Tungsite are supplied in a variety of mesh sizes. Recommended for resistance to extreme abrasion, or when a serrated cutting edge is required. Outstandingly successful on rotary drill bits, plow shares, cane knives, muller plows, pug mill knives, hammermill hammers and similar parts.

Write for your free copy of "Hard Surfacing by Fusion Welding."

AMERICAN Brake Shoe COMPANY
AMERICAN MANGANESE STEEL DIVISION
411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Foundries at Chicago Heights, Ill., New Castle, Del., Denver, Colo., Oakland, Calif., Los Angeles, Calif., St. Louis, Mo.
Offices in principal cities. Made and sold in Canada by Canadian Ramapo Division of Joliette Steel Ltd., Niagara Falls, Ont.

Powell has been associated with the Wheeling Steel Corp., the Owens-Illinois Glass Co., and the Youngstown Sheet & Tube Co. He joined Freyn in 1940.

T. H. Cable was appointed a member of the sales department, central staff of Koppers Co., Inc. Mr. Cable has been eastern advertising manager for the Westinghouse Electric Corp. for the last three years, with headquarters in New York.

Vernon W. Kraetsch was named assistant to comptroller of the American Steel & Wire Co., Cleveland, Ohio. Mr. Kraetsch, a native of Springfield, Ill., was graduated from the University of Illinois in 1939 with a bachelor of science degree in accounting and joined the wire company in Cleveland shortly afterward as a technical apprentice. In 1941 he was made procedure analyst at the wire company's Waukegan works at Waukegan, Ill. Early in 1942 he returned to Cleveland to join the comptroller's staff as staff assistant of the procedure division. Shortly after that he became senior procedure analyst and after a series of promotions became procedure supervisor in 1944. In 1947 he was named Cleveland district works accounting supervisor and became assistant works accounting supervisor in 1948, a position he has held since.

Charles E. Walker, Jr. was elected vice president of Dravo Corp., Pittsburgh, Pa. Mr. Walker will continue as secretary and director of industrial relations of Dravo Corp., which positions he has held since September 1944. Mr. Walker joined Dravo in 1933 as a member of the accounting department. He successively held positions of assistant secretary, assistant treasurer, assistant auditor and auditor, when at the beginning of expanded war activities he was designated as assistant to the president in February 1942. He has been director of industrial relations for the past four years.

N. B. Ornitz, vice president, was appointed manager of foundry operations in the Pittsburgh district for Blaw-Knox Co. This is a new position created in connection with the improvement program now in progress at three of the company's local foundry plants, and is

N. B. ORNITZ

in addition to Mr. Ornitz's other duties. After an extensive technical background in metallurgy and experience in the manufacture of tubing and alloy steels, Mr. Ornitz founded the National Alloy Steel Co. in 1927. This unit, located at Blawnox, Pa., became part of the Blaw-Knox Co. in 1929.

Wellman will build it

- Special Cranes
- Gas Producer Plants
- Charging Machines
- Industrial Furnaces
- Car Dumpers
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- Gas Reversing Valves
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- Ore Bridges
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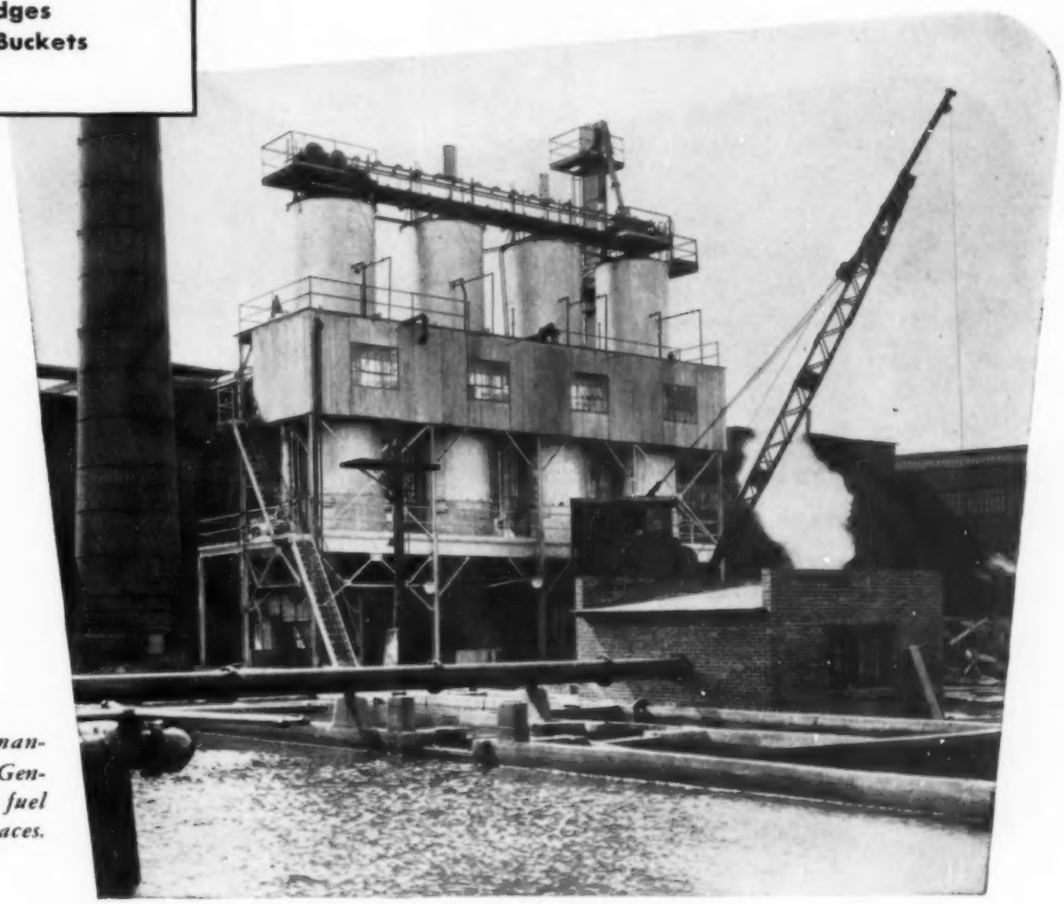
Wellman-Galusha Clean Gas Generators

Built exclusively by Wellman



Four 10 ft. Wellman-Galusha Clean Gas Generators supplying fuel for steel mill furnaces.

• Only Wellman builds the Galusha Clean Gas Generators that so ideally meet your requirements with efficiency and economy. These generators combine, in a *complete* machine, the rotary grates, ample fuel storage bin, and provisions for generating the steam required for making the gas. Even the lowest-priced grades of Anthracite and coke can be satisfactorily gasified.

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DE LAVAL VERTICAL DRIVE REDUCERS

A complete line of De Laval vertical speed reducers, in both single and double reductions, is available for driving agitators, mixers, and many other types of vertical shaft equipment.

If vertical drives are your problem, consult De Laval.

*This single reduction De Laval Worm Gear Reducer is available with many standard gear ratios and is but one of the 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

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Worm Gear Division

DE LAVAL

De Laval Steam Turbine Co., Trenton 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

P. M. Offill, Jr., was appointed to represent George P. Reintjes Co. in the sale of suspended arches and walls for the Pittsburgh, Pa., area. Mr. Offill had been representing Reintjes in the California district.

Frank Willmott, Chicago district sales manager of E. W. Bliss Co. retired on October 1st after 24 years' service with the company. Mr. Willmott started his 43 year career in the metal working industry as an apprentice die maker with J. Stevens Arms Co. and

FRANK WILLMOTT

served consecutively with Stevens Duryea Automobile Co., Continental Motors, Chalmers Motor Co., Oakes Stamping, and Nordyke & Marmon Co. He joined the Toledo Machine & Tool Division of the Bliss Co. in 1923 as sales engineer.

Bernard E. Meyer has been named to succeed Mr. Willmott as Chicago district sales manager for E. W. Bliss Co. He joined Bliss in 1925 after graduating from Cornell University with a mechanical engineering de-

BERNARD E. MEYER

gree. Mr. Meyer, a sales engineer covering the Chicago area since 1928, has been on special assignment for the past four months in the general sales organization at Bliss' executive offices in Toledo.

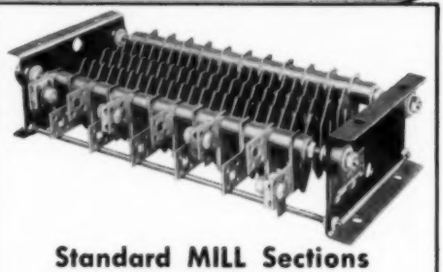
Henry T. Sulcer has been appointed general manager of Graver Water Conditioning Co., 216 West 14th Street, New York, N. Y. The water conditioning company was recently formed to extend the water treatment and liquid conditioning facilities of the company, which

Two-way Improvement with EC&M *TAB-WELD* Resistors

1 - STABILIZES the resistance value.

2 - ELIMINATES TROUBLE in concealed areas.

OFF-SET in each plate gives Intimate Contact at grid-eyes SPOT-WELDS insure continuous path independent of clamping-nuts



Standard MILL Sections have these features . . .

1. All grids in series—all grids of the same size.
2. Capacities up to 150 amperes per section. External paralleling of sections for larger capacities as needed.
3. Uniform mounting-hole dimensions.
4. Replacement simplified — taps in place for affixing external leads.

Usually mounted overhead or in other remote locations, electrical resistors often receive little inspection or preventative maintenance until the damage has been done. But now, the problem of burning at grid-eyes, at tap-plates, and the need for periodic tightening of clamping-nut pressure is eliminated with EC&M *TAB-WELD* Plate Resistors.

Unlike previous resistor-sections depending on end-nuts for contact-pressure, these new EC&M Resistors are designed with *Tab-ends* which are spot-welded to give a *continuous* path throughout each section. Tap-plates also, are welded in position at frequent intervals for affixing external leads. Only EC&M *TAB-WELD* Plate Resistors offer these improvements for lower up-keep—prolonged life. *And don't overlook the corrosion-resistant properties of these steel plate resistors.*

When replacing existing installations or making new layouts, use EC&M Bulletin 942 *TAB-WELD* Plate Resistors

THE ELECTRIC CONTROLLER & MFG. CO.

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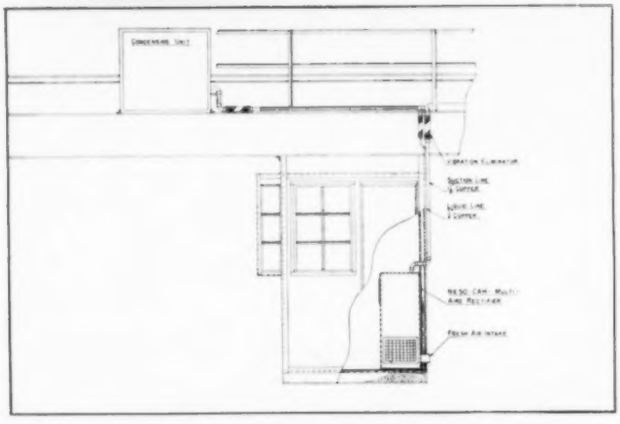
Sizes, Weights, Costs REDUCED in...



1950 MODELS
LINTERN
Aire-Rectifier

The 1950 models of the "Little Giant" split system Aire-Rectifier now in production involve significant reductions in size and weight, yet with no sacrifice in capacity. Consequent savings in production are passed along to the buyers.

There are three new models in this series: 501AC-14 of 14,000 BTU capacity; 501AC-18 of 18,000 BTU capacity; and 501AC-27 of 27,000 BTU capacity. Typical of the saving in size and weight is 501AC-14. Its condenser unit measures only 46" long, 53" high, and 21" wide — weight, 1,225 lbs, as compared with the previous model, which measured 57" long, 49" high, and 23" wide — weight, 1,420 lbs.

All electrical equipment is protected and gives longer operating life.

The split system offers several definite advantages. (1) Reduced engineering costs. (2) Big savings by elimination of expensive, efficiency-reducing air ducts. (3) Higher cooling efficiency in the cab. (4) Greater flexibility in location of all equipment. (5) Lengthened life of operating equipment because of protection from excessive radiant heat and greater accessibility for service. (6) Location of Aire-Rectifier on existing cranes without moving any equipment. Savings run from $1,000 to $2,500 per installation.

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THE LINTERN CORPORATION
54 LINCOLN AVENUE • BEREA, OHIO

has manufactured this type of equipment for 40 years. Mr. Sulcer had been general auditor of the parent company, which he joined in 1948 after a wide legal, industrial manufacturing and administrative experience. Aiding Mr. Sulcer as assistant general manager is **Edward W. Welp**, formerly sales manager of the Graver Water Treating division, who will make his headquarters in the Chicago office. **S. D. Barr,** who was previously in charge of Eastern District Sales, has been advanced to the position of general sales manager with offices at New York.

Philip B. Niles has been elected a vice president of Yale & Towne Manufacturing Co. Mr. Niles will join Yale & Towne on November 7, and will devote his attention to marketing and to the development of executive personnel throughout the company. He has been public relations director for the Owens Illinois Glass Co., Toledo, Ohio, since early in 1948, and had previously been vice president of the American Water Works Co.

Clarence L. Holmberg was named superintendent of business procedures at the Indiana Harbor, Ind., works of Inland Steel Co. Mr. Holmberg had been manager of the order division of Inland's sales department since 1946. **Henry N. Schumacher** has been named to succeed Mr. Holmberg as manager of the order division. Mr. Holmberg began his Inland service in 1927 in the central shipping department of the Indiana Harbor works. He was transferred to the sales department in 1933 and in 1942 became a sales representative in the Chicago district sales office. In 1944, he was appointed assistant manager of the order division. Mr. Schumacher entered the employ of Inland in March, 1934, as a laborer in the open hearth department at the company's Indiana Harbor works. Advancing through several departments at the works, he was transferred ultimately to the Chicago office as head of the sheet section in the order division in 1946. Mr. Schumacher became assistant manager of the order division in 1948.

Max L. Murdock, acting manager of the centrifugal pump department at Allis-Chalmers Norwood, Ohio works, has been promoted to manager of the department succeeding **H. C. Gaton,** retired. **Woodrow Brixius,** formerly application engineer in the company's West Allis Works centrifugal pump department, has been named assistant to Murdock, and **Paul B. Hugenberg** has been appointed application engineer in charge of sales and orders.

J. R. Connell was named assistant purchasing agent of Babcock & Wilcox Tube Co., Beaver Falls, Pa. Mr. Connell attended the University of Pittsburgh. Since 1942 he has been in charge of the purchasing department of Babcock & Wilcox Tube Co.'s welded tube division at Alliance, Ohio. Prior to association with the company Mr. Connell had been with the sales and metallurgical divisions of the Carnegie-Illinois Steel Corp. in Chicago and Pittsburgh.

H. R. Salisbury was elected president of Air Reduction Sales Co., New York, N. Y. Mr. Salisbury has been with the organization over twenty-three years in various executive capacities. Appointed vice presidents were **H. F. Henriques,** general sales; **J. J. Lincoln, Jr.,** railroad sales and sales services; **S. B. Stouffer,** distribution; and **N. L. Wisser,** field office management.

PARALLOY

REGISTERED TRADE MARK

A name of Quality in

- PINCH ROLLS
- COILER ROLLS
- TENSION ROLLS
- STEEL MILL ROLLS

NO SCRATCHING OR GALLING

500-600-BRINNEL

MORE TONS PER PASS

OTHER PRODUCTS

HYDRAULIC SLAB AND BILLET PILERS
STRIP AND SHEET OILING EQUIPMENT
SHEET SCRUBBER AND CLEANING LINES
HOT SAWS—ROCKING AND SLIDE TYPES
HOT BEDS—COOLING BEDS—TRANSFERS
BILLET EJECTORS—PINCH ROLL STANDS
SLITTERS—SPECIAL SHEARS AND GAUGES
TILTING TABLES—TRAVELING AND LIFTING TABLES
CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
STRIP STEEL COILERS AND REELS—SCRAP BALLERS
RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
SHEET GALVANIZING LINES—WIRE PATENTING FRAMES
STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

The Youngstown Foundry & Machine Co.

Youngstown, Ohio

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

R. J. Nekervis has been appointed supervisor of metallurgical development and **R. M. MacIntosh** has been appointed supervisor of chemical development for Tin Research Institute, Inc., Columbus, Ohio. Both appointees have been with Battelle Memorial Institute for the last eight years where they have been handling problems connected with tin.

Frederick Wenzel was appointed to the post of works manager and **W. C. Christianson** was named sales manager of Trent Tube Co. Mr. Wenzel was plant superintendent of Trent prior to his appointment. He joined Trent in June, 1944. He formerly was associated with the Louis Allis Co. of Milwaukee, Wis., as an electrical engineer. Mr. Christianson joined Trent in 1946 as assistant sales manager. He formerly was associated with Globe Steel Tubes Co. of Milwaukee as assistant to the sales vice president.

Carl E. Berndt was appointed as manager of warehouse products for Timken Roller Bearing Co. **Anthony J. Lombardi** has been appointed warehouse supervisor, replacing Mr. Berndt, Mr. Berndt, who is 38 years old, went to Timken 16 years ago as a mill operator. He was then transferred to the graphitic warehouse and later completed a sales training course in the metallurgical department. In 1940, Berndt became assistant to **F. R. Bonte,** development engineer in the steel sales department. Mr. Lombardi first began work in the company's finishing department. He also was transferred to the graphitic warehouse which is now called the steel sales warehouse. Prior to his present appointment as warehouse supervisor, Mr. Lombardi served as a foreman for five years. He spent 11 months in the Army during World War II.

The following appointments and transfers of sales personnel have been announced by the General Refractories Co., Philadelphia, Pa.: **Roger W. Braden,** formerly manager of the Detroit warehouse, has been reassigned as manager of the New York warehouse. **DeWitt C. Clement, Jr.** has been transferred from the estimating department to the New York warehouse. He will be a member of the warehouse sales force. **Alan R. Eakins** will be transferred from the estimating department to the New York warehouse. He will be a member of the warehouse sales force. **Richard H. Lightfine** has been transferred from the New York warehouse to the New York district sales office. **James S. McKelvy** has been transferred from the estimating department to railway sales. He is temporarily assigned to the St. Louis office and will make his headquarters in Chicago after January 1, 1950. **William C. Noble** has been transferred from the estimating department to the Philadelphia district sales office. **Karl E. Spaeth, Jr.** has been transferred from the New York warehouse to the Pittsburgh district sales office. **Richard A. Stephens** has been transferred from the New York warehouse to the Philadelphia district sales office.

R. S. (Bob) Harris, who has been with Dowell, Inc., since 1940, has been added to the organization's district operating station in Houston, Tex. Mr. Harris, formerly stationed in Beaumont as sales engineer, has had several years experience in industrial treating.

INDUSTRIAL GEAR MFG. CO. CHICAGO
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DUROCASE
GEARS
SERVE THE STEEL INDUSTRY
A NAME TO DEPEND ON FOR
HARD WEARING
GEARS
Each Tooth Deep Case Hardened penetrating well into Core for Long Life in grueling service.
Send for a pictorial trip through our plant. You'll be sure your orders will be well taken care of.
INDUSTRIAL GEAR MFG. CO.
4527 VAN BUREN STREET CHICAGO 24, ILLINOIS

BROWNING
MILL TYPE CRANES have
Plenty of Strength WHERE
STRENGTH IS NEEDED!
Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane perfectly to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.
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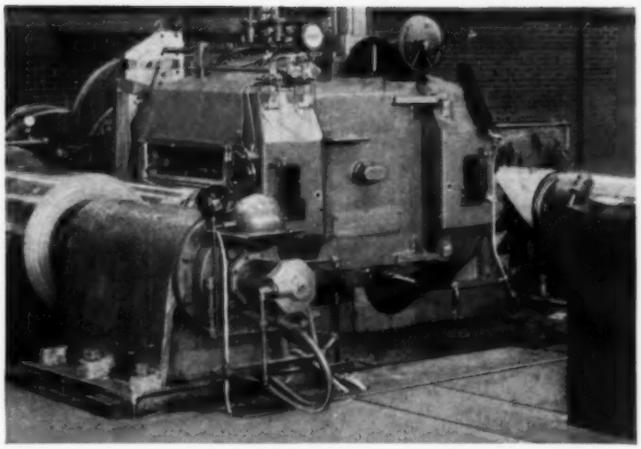
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

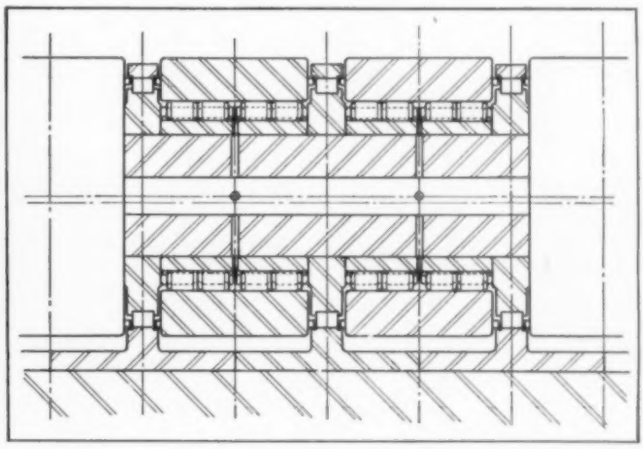
Torrington Bearings help Sendzimir mills roll steel to tissue thinness



The Sendzimir cold strip mill above, engineered by Armzen Company, rolls a super-accurate strip to tolerances of one to two ten-thousandths of an inch. Secret of its accuracy, as well as its ability to roll fine gages, is its use of small diameter work rolls with a radically new roll-backing principle.

The backing elements consist of these shafts carrying special Torrington Radial Roller Bearings alternating with saddles. Outer races of these bearings are in direct contact with either the work or intermediate rolls. The roll separating force is transmitted through intermediate rolls to these bearings.

To provide tremendous capacity, each bearing employs four rows of rollers, with a cage assuring positive roller guidance. The outer race has an exceptionally heavy section to prevent distortion and provide a rigid backing for intermediate rolls. Precision construction assures minimum wear and long service life.



This cross-section of the backing elements shows how roll separating forces, carried by the Torrington Roller Bearings, are transmitted through shaft and saddles to the housing. This construction and the high radial capacity of the bearings account for the exceptional rigidity and accuracy of the mill.

This is but one outstanding example of Torrington's ability to engineer anti-friction bearings to meet specific and exacting application requirements. Call on Torrington to solve your friction problems, routine or unusual. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.

TORRINGTON STRAIGHT ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller Needle • Ball • Needle Rollers

If

If you can keep your head when all about you
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you,
But make allowance for their doubting too:
If you can wait and not be tired by waiting,
Or, being lied about, don't deal in lies,
Or being hated don't give way to hating,
And yet don't look too good, nor talk too wise;

If you can dream — and not make dreams your master;
If you can think — and not make thoughts your aim,
If you can meet with Triumph and Disaster
And treat those two impostors just the same:
If you can bear to hear the truth you've spoken
Twisted by knaves to make a trap for fools,
Or watch the things you gave your life to, broken,
And stoop and build 'em up with worn-out tools:

If you can make one heap of all your winnings
And risk it on one turn of pitch-and-toss,
And lose, and start again at your beginnings,
And never breathe a word about your loss:
If you can force your heart and nerve and sinew
To serve your turn long after they are gone,
And so hold on when there is nothing in you
Except the Will which says to them: "Hold on!"

If you can talk with crowds and keep your virtue,
Or walk with Kings — nor lose the common touch,
If neither foes nor loving friends can hurt you,
If all men count with you, but none too much:
If you can fill the unforgiving minute
With sixty seconds' worth of distance run,
Yours is the Earth and everything that's in it,
And — which is more — you'll be a Man, my son!

RUDYARD KIPLING
Born
DEC. 30, 1865
Died
JAN. 18, 1936

FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
TELEPHONE COLLECT 3-4186
Established 1890 Incorporated 1895

A. Myles Younger has been elected vice president in charge of sales for Atlas Mineral Products Co., Mertztown, Pa. Mr. Younger joined the firm as a chemical engineer in 1939 and in the interim has held positions as midwest sales manager, plant manager of the California plant, general manager of the Texas division, and general sales manager.

David Neill was appointed Cincinnati sales representative for Farrel-Birmingham Co., Inc., for gears, gear units and flexible couplings manufactured in the company's Buffalo, N. Y., plant. Mr. Neill first joined the F-B sales department in April, 1945, after spending the three previous years in the company's gear manufacturing division.

Obituaries

C. H. Lenhart, 47, vice president, H. A. Brassert and Co., New York, N. Y., died October 18. Mr. Lenhart was formerly division superintendent of iron production, Kaiser Steel Corp., and prior to that was assistant superintendent of blast furnaces, Carnegie-Illinois Steel Corp., Duquesne, Pa.

Lewis L. Middleton, vice president, Sheffield Steel Corp., Kansas City, Mo., passed away on Monday, September 19, 1949.

A. J. Jennings, 54, vice president in charge of sales, Cleveland Worm & Gear Co., of Cleveland, Ohio, and of its associate company, Farval Corp., died following a heart attack October 30, 1949. Mr. Jennings was born in Adrian, Mich., and began his business career with the E. F. Houghton and Co., of Philadelphia, Pa.,

ACROSS

12 The wolf look
15 Sailor
18 The fun in football
21 Hot-dip metal
27 Skill
30 A soft answer

12 DOWN* is the answer

*OAKITE provides the right solution for every metal-cleaning process:

Cleaning in tanks	Pickling
Cleaning in machines	Burnishing
Electrocleaning	Barrel cleaning
Pre-paint treatment	Paint stripping
Steam-gun cleaning	Rust prevention

FREE For advisory service on jobs that are giving you trouble, write to Oakite Products, Inc., 19 Thames St., New York 6, N. Y.

OAKITE 1909 1949 40th ANNIVERSARY YEAR

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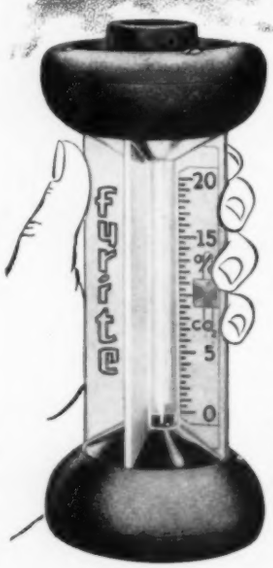
INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

SMOKE PREVENTION *with the...* **FYRITE CO₂ INDICATOR**



The relationship of the CO_2 test to smoke prevention is very close. A boiler that smokes is a boiler that is burning fuel inefficiently. CO_2 percentage in the flue gases—easily and quickly measured with the FYRITE—is an accurate, dependable index of combustion efficiency.

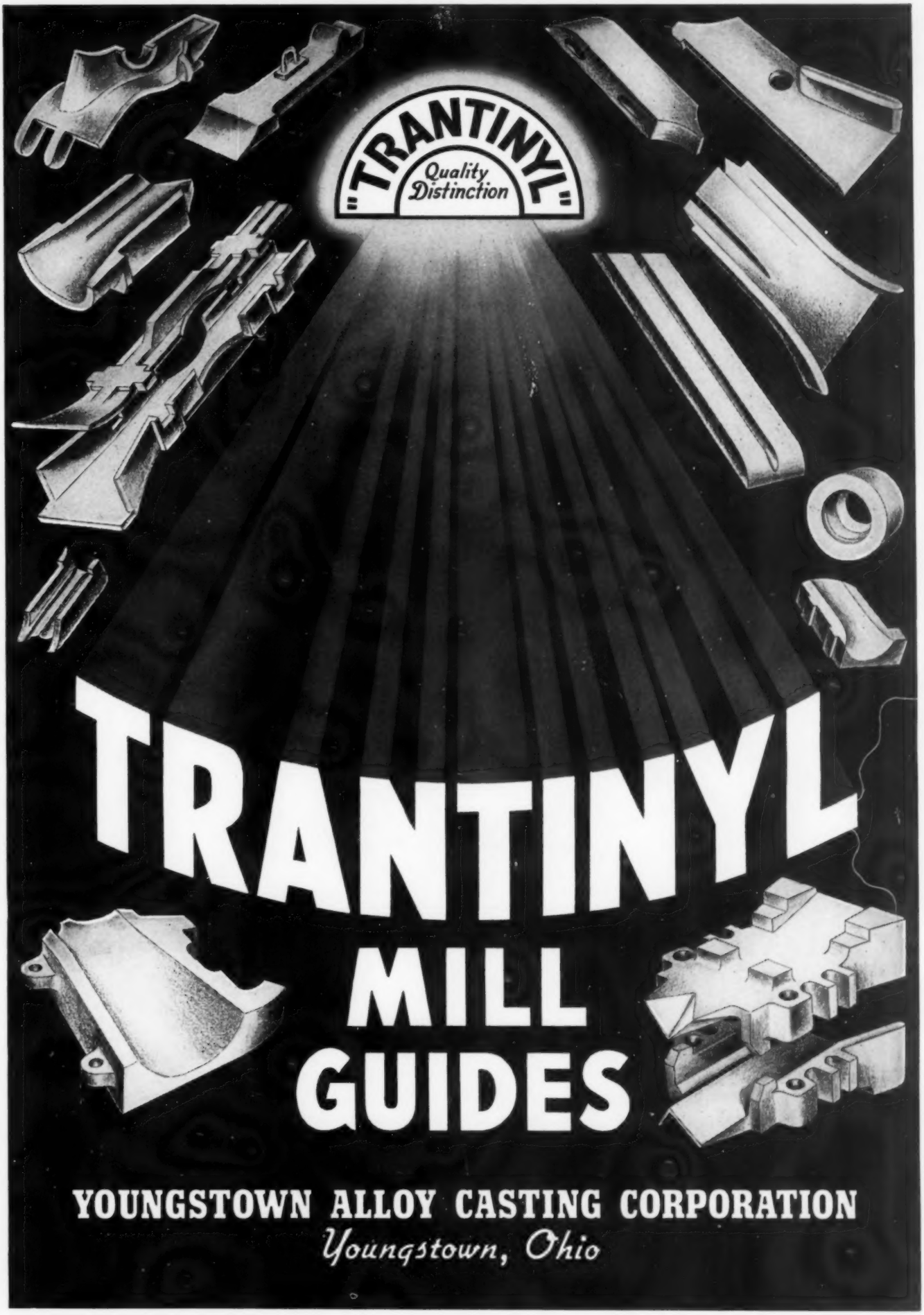
Checking CO_2 content of the flue gases regularly with the FYRITE is your best assurance of continuously maintaining maximum combustion efficiency, which insures fuel economy, long furnace life and freedom from smoke nuisance. This freedom from smoke is doubly important now with smoke abatement ordinances being enacted in a rapidly growing number of localities.

There is nothing tricky or complicated about a CO_2 test with the FYRITE—requires no skill or special training—there are no valves, clamps, or leveling bottle to manipulate—one test takes less than a minute. More than 13,000 in successful use.

Write for Bulletin 740

BACHARACH
Industrial Instrument Co.
7000 BENNETT STREET
PITTSBURGH 8, PA.

OXYGEN INDICATOR *employing FYRITE principle, for direct oxygen analysis, also available. Ask for Leaflet 700.*


TRANTINYL
Quality Distinction
TRANTINYL
MILL
GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

producers of industrial lubricants. After 14 years, he left Houghton to become vice president and general manager of Lubrication Devices, Inc., of Battle Creek, Mich., predecessor company to the Farval Corp. and a pioneer manufacturer of centralized systems of industrial lubrication. He came to Cleveland in 1932 when Farval was purchased by the Cleveland Worm & Gear Co. As one of the early and most active figures in the American Society of Lubrication Engineers, Mr. Jennings served on its committees and delivered many papers before the national meetings of the Society. He was active in the Association of Iron and Steel Engineers and the American Gear Manufacturers Association, serving at the time of his death as chairman of the General Commercial Committee of AGMA.

A. J. JENNINGS

Charles S. Traer, chairman of the board of Acme Steel Co., Chicago, Ill. passed away suddenly on October 25, 1949 of a heart attack. Mr. Traer had just completed 30 years of active service with the Acme Steel Co., having started with them as works manager in 1919. He subsequently served as treasurer and works manager — 1922–1935, vice president and manager of production — 1935-1941, and president — 1941–1948. He had been chairman of the board since 1948. Mr.

CHARLES S. TRAER

You can get what you want in the complete range of Jones Herringbone Speed Reducers

YOU will find this 128-page catalog of Jones Herringbone Speed Reducers helpful in the selection of reducers in accordance with A.G.M.A. recommended practice for all conditions of service. Jones Herringbone Speed Reducers are built in single, double and triple reduction types and in every standard ratio in ratings ranging from 1.25 H.P. to 440 H.P.

All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Liberal stocks are carried to facilitate shipments.

Catalog No. 70 will save you time and effort in laying out drives that call for Herringbone gears.

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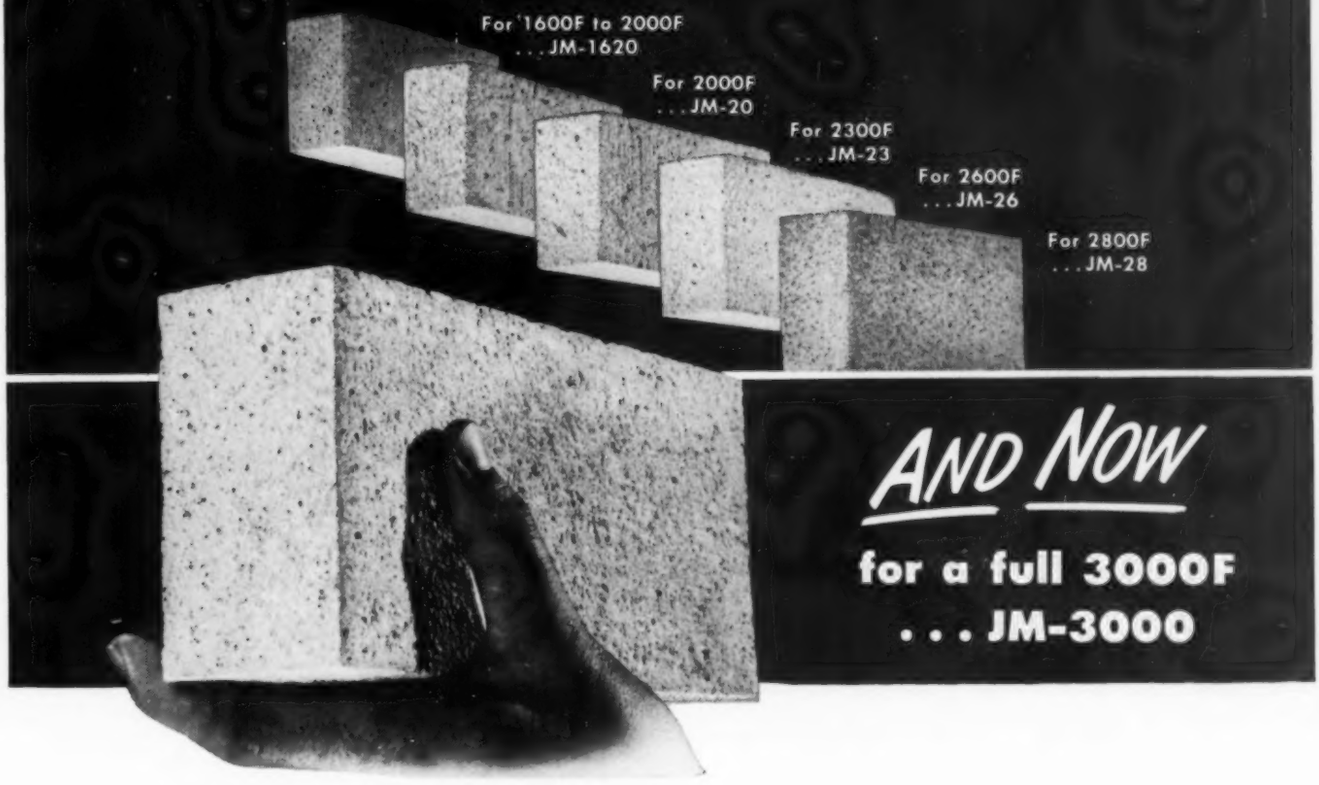
Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • PULLEYS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES • ANTI-FRICTION
PILLOW BLOCKS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

MEET the family of Johns-Manville Insulating Fire Brick . .



HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a *quick heating* insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† *24-hr simulative service panel test for JM-3000; 24-hr soaking period for other brick.*

* *Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.*

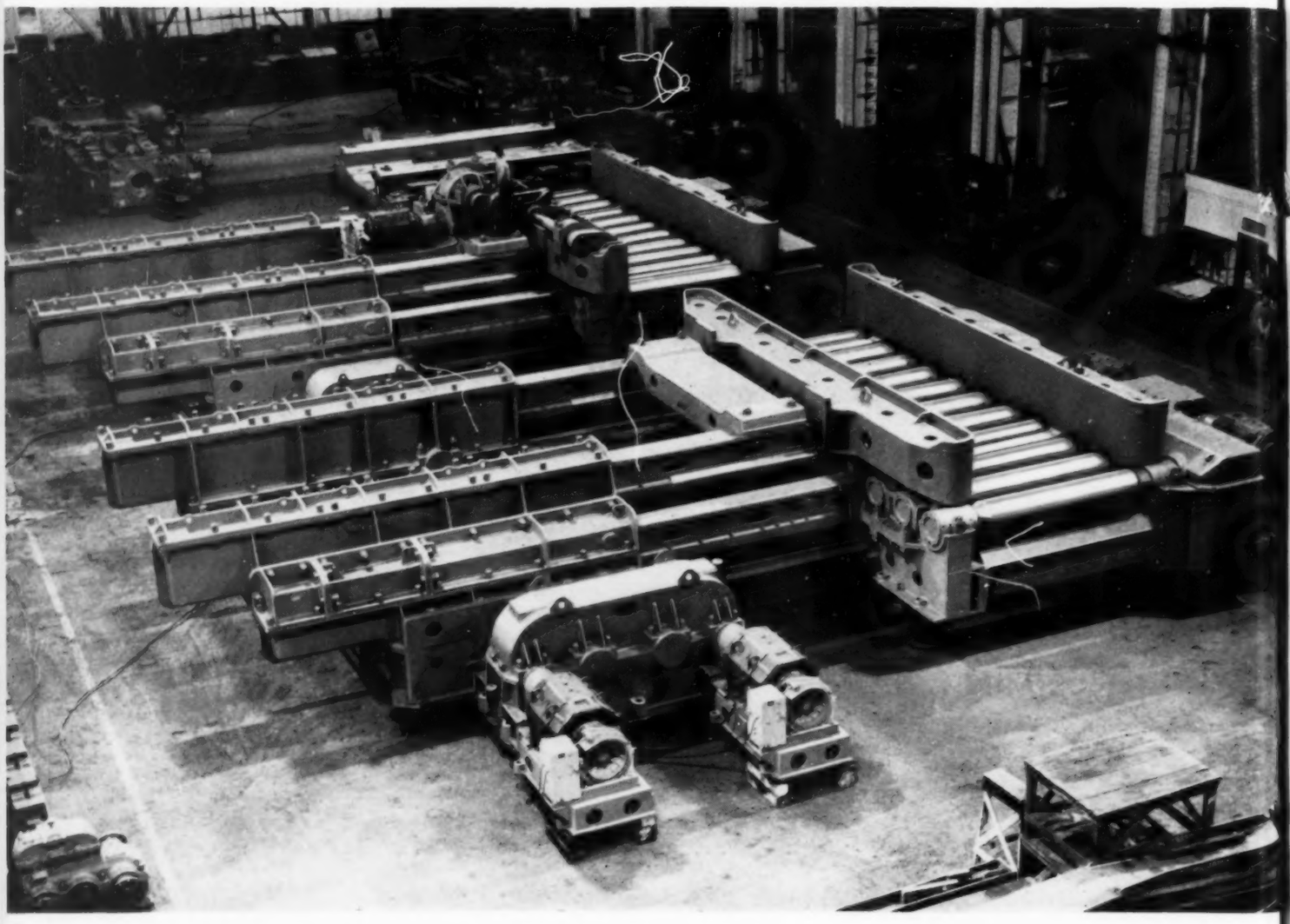
Note: Above tests are in accordance with A.S.T.M. tentative standards.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville First in INSULATIONS

BUILT BY MORGAN Engineering

40″ BLOOMING MILL TABLES AND MANIPULATOR



Shop view of 40″ Blooming Mill Manipulator and Mill Tables, furnished with a Morgan 40″ Blooming Mill, having Twin Motor Drive. Manipulator is of the overhead type, electrically driven with retractable heads so the table rollers can be removed without dismantling the manipulator heads.

Table girders are of cast steel box section type with integral oil trough on drive side. All gears are totally enclosed, operating in oil, and have hardened teeth. All bearings are of anti-friction type, lubricated through a centralized motor operated system.

Your inquiries appreciated.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

HIGH-SPEED CONTINUOUS WELDING PROCESS CAN NOW BE APPLIED TO STAINLESS STEEL

▲ When Air Reduction announced a year ago the development of the "Aircomatic" or inert gas-shielded metallic arc welding process for the welding of aluminum, there were strong hints that it would also be economically available for other metals before long. In the intervening year, the process has been successfully applied to the welding of chrome nickel or stainless steels and aluminum bronzes.

Briefly, the Aircomatic welding process revolves around the continuous feeding of a coiled wire electrode in a gaseous shield through the barrel of a welding gun. High speed continuous deposition of filter metal is possible in all positions with a completely visible arc. Both manual and automatic equipment are available.

When applied to the welding of stainless, this process has certain specific advantages over the older and better known methods. For example, the filler metal is carried across the arc and deposited in the weld virtually without loss of alloying elements.

To illustrate, the Aircomatic transfers across the arc virtually 60 per cent of the titanium that may be present. Existing metal arc welding methods lose almost all of it. This makes feasible the use of titanium stabilized filler metal rather than columbium stabilized — a factor of great importance should there be an international emergency.

The Aircomatic process also deposits more stainless steel at a given value of welding current and hence minimizes heat effects in the base metal.

The physical properties of the welded joint obtained equal and sometimes exceed those achieved by other methods. Superficially, the weld surface is dull, but it grinds, buffs, and polishes to any desired finish as easily as welds made by other methods. The welds are sound, without porosity or slag inclusion, nor is there any slag to remove afterwards.

Exceedingly high welding speeds are obtainable. When using 1/16-in. wire (one of the standard sizes) deposition rates in the downhand position of 15 lb per arc hour are possible. In addition, there is no stopping to change electrodes and no stub loss. Since 3/8 in. thick square-edged plates can be welded without further edge preparation, by putting in only two passes — one from each side — there is a further saving in overall fabrication costs.

Joint designs in heavy plates can be modified to have only a small included angle with large savings in welding material and time. Because only a fine wire, 1/16 in. in diameter, must reach to the bottom of the weld groove, and since there is no slag to be trapped, the included angle may be reduced to 30 degrees. The diameters of wire available are .035 in., .045 in. and 1/16 in. in AISI types: 310, 316, 347.

At the present time the most popular method of applying aluminum bronze filler metal is to use coated stick electrodes. With these it is difficult to deposit porosity free welds when using the softer grades of this material. In the Aircomatic, we have a process that has deposited soundly aluminum bronze.

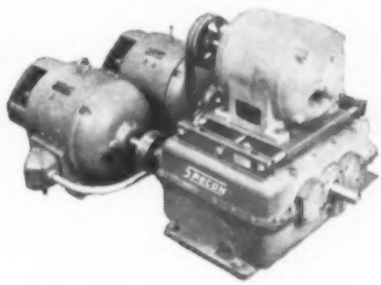
Both manual and machine units are in commercial operation. Delivery is dependent on the successful conclusion of the steel strike.

SPEED CONTROL UNIT HAS HIGH EFFICIENCY

▲ Infinite speed ranges, down to and including zero speed, with constant torque, under fully automatic control, is possible with a newly designed electrical differential speed drive recently perfected by Speed Control, Inc. In the processing of web materials, constant tension or decreasing tension may be maintained between a machine and a winding stand or between two parts of the processing machine, assuring a smooth, even flow of the material.

The new drive, designated as "Specon ED," makes use of a unique motor generator combination. The unit consists of a standard a-c squirrel cage motor of any desired voltage and frequency (or any prime mover of constant rpm), two d-c motors and a differential gear box. The a-c motor, or prime mover, is coupled with 2 d-c motors through the differential gear box. The d-c motors are connected in a closed circuit and require no outside source of power.

In operation, the d-c motors run at varying controlled speeds within a



limited 3:1 range and are the means of controlling the torque and unlimited speed range of the output shaft.

When the output shaft is at highest speed, one d-c motor, running at its lowest speed, acts as a generator, feeding its power to the other d-c motor, running at its maximum speed. On the contrary, when the output shaft is at its lower speeds, the other d-c motor acting as a generator runs at its highest speed, feeding its power to the first d-c motor, now running at its slowest speed. Because the slowest speeds of the d-c motors are never below one third of their no-load rate, they develop heavy torques at low speed without the heating-up, due to excessive a-c currents encountered in conventional variable drives. Because a portion of power always flows directly through gears to the output shaft, except at zero speed, the efficiency of the elec-

Oxygen cuts electric furnace decarburization time . . . saves power

J. B. BEAIRD COMPANY, Shreveport, Louisiana, wanted to reduce the normal decarburization time of its electric furnace — without affecting the quality of the finished steel.

George Bellew, Airco Technical Sales Representative, was called in to determine what effect the introduction of oxygen in the molten bath would have on refining time. In each of the three trial "heats" oxygen was run just below the slag metal interface.

Several of the advantages of using oxygen in these "heats" were: greater alloy recovery . . . reduced time and power consumption . . . electrode cost per ton lowered . . . elimination of ore handling and storage . . . increased melting rate . . . increased bath temperatures . . . faster carbon elimination.

To date the J. B. Beaird Company has conducted tests on 200 more "heats" — and is highly pleased with the results.

The use of oxygen for decarburization has now become standard practice.

• • • •

TECHNICAL SALES — ANOTHER AIRCO PLUS-VALUE FOR CUSTOMERS

To assure its customers of high efficiency in all applications of the Oxy-acetylene flame or electric arc, Air Reduction has available the broad, practical experience of its nationwide Technical Sales Division personnel. The collective experience and knowledge of these specialists has helped thousands to a more effective use of Airco processes and products. Ask about this Airco "Plus-Value" service today. Write your nearest Airco office. (In Texas: Magnolia Airco Gas Products Company . . . On West Coast: Air Reduction Pacific Company).

AIRCO **AIR REDUCTION**

Offices in Principal Cities

Headquarters for Oxygen, Acetylene and Other Gases . . . Carbide . . . Gas Cutting Machines . . . Gas Welding Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

trical differential drive, throughout the entire range is considerably higher than is possible where speed changes are effected electronically. One important advantage claimed by the manufacturers is the fact that the drive requires no complicated and expensive electronic control panels but, in most cases, attains the required results without the use of electronic tubes. Where required, however, electronic amplification of control signals is readily available.

Because the differential gearing requires no more attention than an ordinary speed reducer, and the motors are of standard make, and interchangeable, the unit provides a high degree of dependability with a minimum of maintenance.

The driving motor may be mounted either horizontally or vertically and the unit is available in any required size and capacity.

VALVE LUBRICANT GIVES FULLY AUTOMATIC ACTION

▲ Automatic lubrication for millions of pressure lubricated plug valves is now possible without use of mechanical accessories or force-feed mechanisms. The secret is in a new "energizable" valve lubricant which provides fully automatic action to maintain anti-leak sealing efficiency and to reduce maintenance costs.

No lubricant heretofore known has the characteristics for storing within itself energy to be used in distributing its lubricating qualities throughout a valve system over a prolonged period of time. This new compressible lubricant, christened Hypermatic, allows automatic lubrication to be established in valves of the Nordstrom type. The manufacturer predicts this amazing substance, which is available in bulk or grease stick form, will cut lubrication costs from 20 to as high as 90 per cent. In many instances valves may be serviced only 1/10 as often. With the large number of valves in many installations, Hypermatic is expected to make substantial savings through reduced valve maintenance costs and extended valve life.

From 50 to 100 per cent more Hypermatic may be injected into lubricated valves of the Nordstrom type than standard, non-automatic compounds. In so doing, energy is

This **HOMESTEAD VALVE** opens or closes

instantly . . . every time . . . any time

IT'S STICK-PROOF

BECAUSE IT'S LEVER-SEALD

HOMESTEAD LEVER-SEALD QUARTER-TURN VALVES have been first choice for more than 16 years in services where extremes of temperature or pressure, or corrosive fluids, cause ordinary valves to "stick" or "seize".

They are "stick-proof" because built into each valve is a powerful lever-and-screw device that prevents sticking and assures positive action at all times under all conditions.

They operate faster too, than screw-stem type valves . . . 16 to 28 times faster. And the quarter-turn principle makes them ideal for installation in restricted areas, next to walls, floors, ceilings, congested piping and other obstructions where other types of valves could not be used. Next time you have a sticking or damaged valve replace it with a Homestead LEVER-SEALD Quarter-Turn Valve. You'll never be satisfied with ordinary valves again.

Homestead Lever-Seald Quarter-Turn Valves are available in metals and alloys to suit your needs in sizes from 1½" to 10" for pressures from vacuum to 1500 lbs.

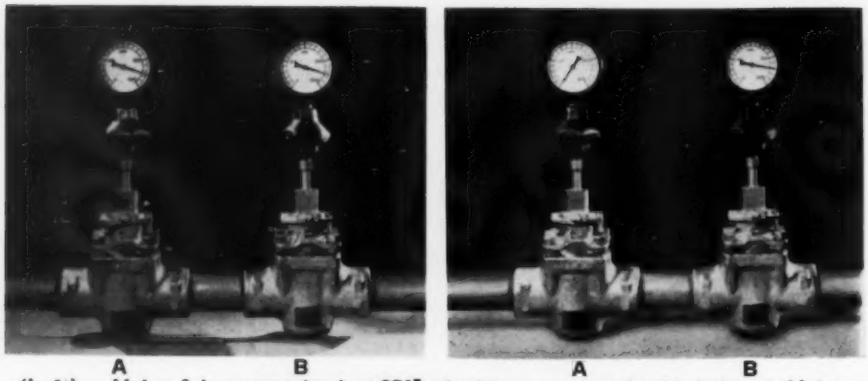
- **Instant Stick-Proof Operation.**
- **Quarter-turn fully opens or closes.**
- **Seating surfaces always protected. Corrosion practically eliminated.**
- **Unobstructed straight-line fluid flow.**
- **All moving parts protected from effects of service conditions and weather.**

For full particulars send for "Valve Reference Book No. 39-3." Write today.

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892"

P. O. BOX 21 **CORAOPOLIS, PA.**



(Left) — Valve A is pressurized at 350 psi with non-energized lubricant. Valve B is using automatic energized lubricant. (Right) — Six months later: Valve A has dropped to 0 psi. Valve B shows negligible decline.

"stock-piled" for future use. Should Hypermatic become depressurized over a long period of time or after a multiple of valve closures, its lubricating qualities revert to those of the non-energizable type. Hypermatic may be re-energized by simply turning the lubrication screw. The lubricant may be added at any convenient time, so it is unnecessary to maintain linemen on a definite servicing schedule because the inherent flexibility and sustained energy of the product virtually "thinks" and acts in the event of a leak.

Valves serviced with this new lubricant are ever-ready to meet emergency operation without the operator first having to stop and replenish the valve with lubricant before operating. Maintenance of the protective film on the valve's sealing surfaces prevents channeling, thus increasing valve life as well as stopping leaks.

Valves now in service need not be purged of old lubricant, since Hypermatic gradually forces it out under normal usage. Use of Hypermatic does not change the range of pressures recommended for each type or model of valve.

DEVELOP NEW MORTAR FOR SILICA BRICK

▲ General Refractories Co. has recently placed on the market a new mortar, "Grefco Silbrik Bond," for use in construction with silica brick and for repairs to all silica brick construction, particularly that in open hearth and electric furnaces and in glass tanks.

The new mortar offers the highest available quality in workability and refractoriness, the two properties of most importance in a material that must withstand the high temperatures and chemical attack to which silica brick construction is subjected. The exceptional workability and refractoriness result from the mortar's special composition and fine texture.

The new mortar is carefully ground and is composed of the purest silica obtainable. The mortar is prepared by washing top quality silica sand until all clay and other impurities are removed. This washing of a silica sand already selected for its high purity, gives "Silbrik Bond" an alumina content that is extremely low (0.20 per cent). To all intents and purposes the refractoriness of silica mortar is gov-

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TO IMPROVE PRACTICALLY ANY PHASE OF STEEL PROCESSING, TO CUT FUEL AND LABOR COSTS

The bulletin illustrated is not just a piece of sales literature but a complete 24 page treatise on the instrumentation and automatic control of steel making and heat treating furnaces. You'll want a copy for your reference files, want to profit from its practical, authoritative information.

And remember as you read it, Hays engineers are thoroughly qualified and ready to work hand-in-hand with you in solving your own specific instrumentation and control problems . . . without obligation.

Write for your copy today . . . Ask for Bulletin No. 48-750 (covering heat-treating furnaces). Companion edition covering open-hearth furnaces will also be included.

Steel that's better, with more uniform grain structure . . . maximum production because of continuous equipment performance . . . fewer rejects . . . lower fuel, maintenance and labor costs—these are advantages you can count on when you use Hays instruments and controls for:

Annealing
Brazing
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Cyaniding
Enameling
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Hardening
Heating
Heat treating
Melting
Nitriting
Normalizing
Tempering
Welding

For indicating and controlling:
Pressure
Flow
Furnace Draft
Fuel air-ratio
Gas analysis

Inquiries invited on any of these specific applications.

The HAYS CORPORATION
Since 1901 COMBUSTION & INDUSTRIAL INSTRUMENTS & CONTROL
MICHIGAN CITY, INDIANA, U.S.A

erened directly by the alumina content.

Nor does the bonding agent deteriorate its refractory properties. Most air-setting mortars contain sodium silicate for bonding. In storage and in use sodium silicate is attacked by the CO_2 in the air or in the furnace gases and its bond rendered virtually ineffective.

The mortar contains no sodium silicate. The bonding agent is one of the special colloidal bonding materials developed by the Grefco laboratories in Baltimore. At high temperatures the bonding material fuses to form a high refractory bond between the silica particles.

The unique workability is achieved by the fineness to which the silica is ground and the uniformity of the colloidal bonding material. A suspension in a beaker of water shows no settling after thirty minutes of standing.

BOILER INSTALLATIONS HAVE UNUSUAL FEATURES

▲ The first of six boilers designed for the best heat rate yet attained in any steam electric station in the United States, and constructed for the American Gas and Electric Co. system by Babcock & Wilcox Co., has gone into commerical operation at the Twin Branch plant of the Indiana and Michigan Electric Co. at Mishawaka, Ind.

A pioneer step in high-pressure, high-temperature boiler construction, the new unit incorporates several unusual design features which, judged by net heat input, make it the largest boiler constructed up to this time. The net plant heat rate is 9300 Btu per net kilowatt hour with a boiler efficiency of 90 per cent. It will add 137,500 kw or approximately 185,000 hp per hour to the capacity of the Twin Branch plant.

Under construction since September, 1948, the unit went into preliminary operation in July with such satisfactory results that it has now been placed in commercial operation.

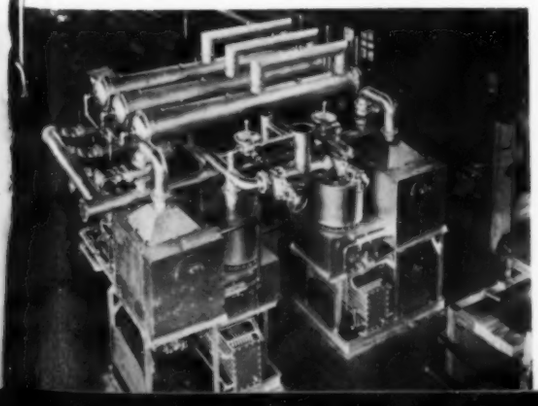
The radiant type boiler is one of six designed and being constructed by Babcock & Wilcox Co. for plants of the American Gas and Electric system. Four more will go into the Philip Sport plant, Graham, W. Va., to be operated jointly by the owners, the Appalachian Electric Power Co. and the Ohio Power Co. The sixth is now being installed at the Tanner's Creek plant, a new station of the Indiana and Michigan Electric Co. near Lawrenceburg, Ind., on the Ohio River.

The boiler has a capacity of 930,000 lb of steam per hour at a drum operating pressure of 2300 psi and final steam temperature of 1050 F. It includes reheater proportioned to handle 840,000 lb of steam per hour with a final pressure of 385 psi and temperature of 1000 F. In one unit

(*Please turn to page 160*)

ATMOSPHERE GENERATOR FOR J&L STRIP MILL

The largest DX atmosphere generating unit ever produced by Surface Combustion Corp., is being delivered to Jones and Laughlin Steel Corp.'s strip sheet mill, Pittsburgh, Pa. Employing the partial combustion of natural gas, this unit will have a capacity of 35,000 cu ft of DX gas per hour. The new generator is to be used for the clean annealing of sheets in J & L's box annealers.



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These 106 new Koppers-Becker Underjet Coke Ovens carbonize approximately 2,600 net tons of coal per day. Built in two batteries, they are equipped with Waste-Gas Recirculation and Blast-Furnace Gas Underfiring Equipment.

Koppers enlarges the scope of its

Koppers Company, Inc., has purchased the Freyn Engineering Company and its subsidiary, the Open Hearth Combustion Company. In becoming a part of the Koppers organization, Freyn will be operated as a wholly-owned subsidiary; it will continue under its present name, at the same address: 109 North Wabash Ave., Chicago 2, Ill.

This plant was constructed by Koppers for recovery of ammonium sulphate, tar, light oil and pure benzol products from the carbonizing of 1,050 tons of coal daily.

Koppers constructed this light oil refining plant in South America to produce pure benzol, toluol, xylol, and solvent naphtha. Capacity is 5,000 gal. of light oil per day.

Freyn Engineering Company, subsidiary of Koppers Company, Inc., designed and constructed this open hearth furnace for the National Steel Company of Brazil.

services to the steel industry

FREYN Engineering Company has specialized in the design and construction of blast furnaces, open hearth furnaces and sintering plants . . . in the engineering of mills and other steel plant facilities.

Koppers Engineering and Construction Division has long been recognized as a leader in the design and construction of coke oven plants, auxiliaries and coal chemical plants.

With this combination of forces, Koppers is in a position to render comprehensive and coordinated design, engineering and construction services to all branches of the iron and steel industry, both here and abroad.

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Pittsburgh 19, Pa.

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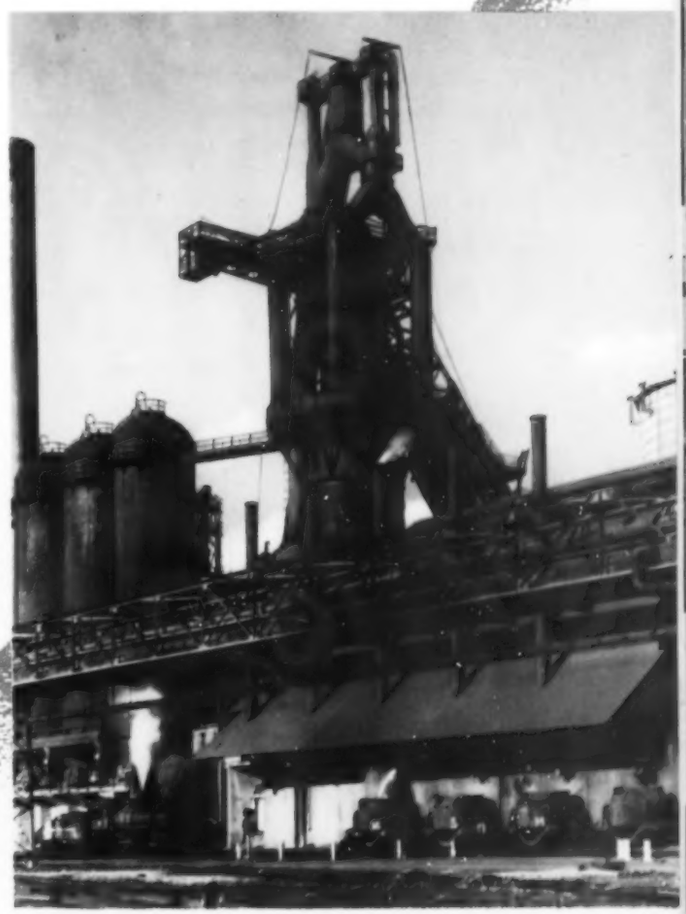

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Assure Your Supply at low cost with

Air Products
OXYGEN GENERATORS

(Continued from page 157)

there is contained the unusual combination of large capacity, high pressure, high primary steam temperature and high reheat steam temperature.

The reheat cycle will produce a kilowatt hour for five per cent less coal than a straight regenerative cycle using the same pressure and temperature.

The real pioneer step in the design of this boiler, according to Babcock & Wilcox engineers, is the method of steam temperature control which makes it possible to maintain high efficiency at substantially reduced capacities. This is accomplished by recirculating the flue gas, taken from the economizer outlet, to the furnace combustion zone.

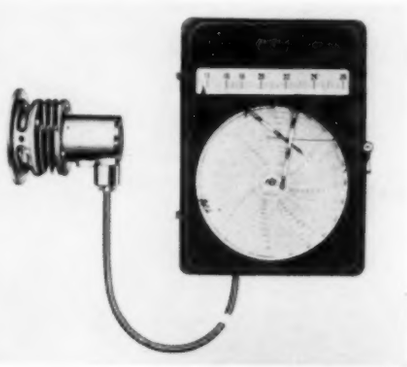
These relatively cool gases reduce the temperature of the gases from combustion and thus reduce the furnace temperature, which, in turn, reduces the heat input to the furnace walls. Consequently, with less heat absorbed by the furnace, more heat remains available for absorption by the superheater and reheater.

An innovation for large capacity boiler units is the use of a pressure furnace in the new boiler. This permits operation without induced draft fans and saves 0.5 per cent of the gross power generated. Operating the furnace under pressure instead of suction eliminates air infiltration or leakage which, until now, increase the fan power required.

The boiler units are being fabricated at the Barberton, Ohio, plant of Babcock & Wilcox Co.

RADIATION PYROMETER DESIGNED FOR 4000 F

▲ The development of a new radiation pyrometer, known as the "Pyrovisor," has just been announced by Bristol Co., Waterbury 20, Conn. The

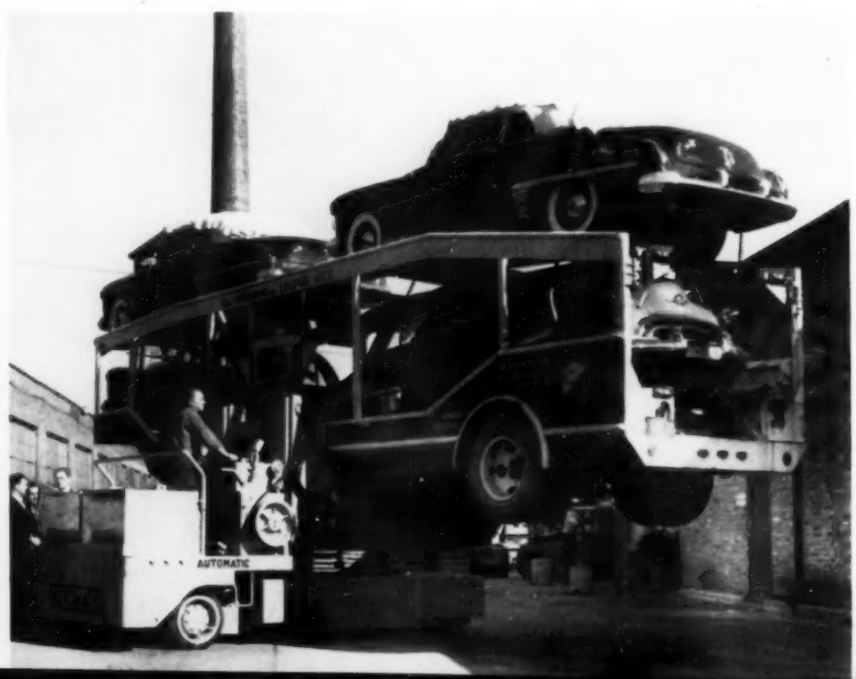


new instrument is designed for indicating, recording, or controlling temperatures up to 4000 F in furnaces and kilns.

The "Pyrovisor" radiation unit, which is the temperature-sensitive

WORLD'S MOST POWERFUL INDUSTRIAL TRUCK

The world's most powerful industrial truck, capable of handling loads up to 110,000 lb, is shown lifting highway trailer with four Oldsmobiles at factory of its manufacturer, Automatic Transportation Co. Load for demonstration weighs about 15 tons, a small job for the electric truck. A 72-volt battery powers the machine, enabling it to lift its massive load at the rate of 2.7 fpm. At the broadest point the truck is 85 in. wide and it has an overall length of 184 in.



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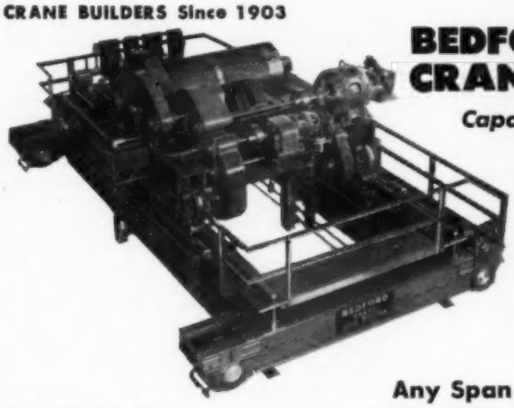

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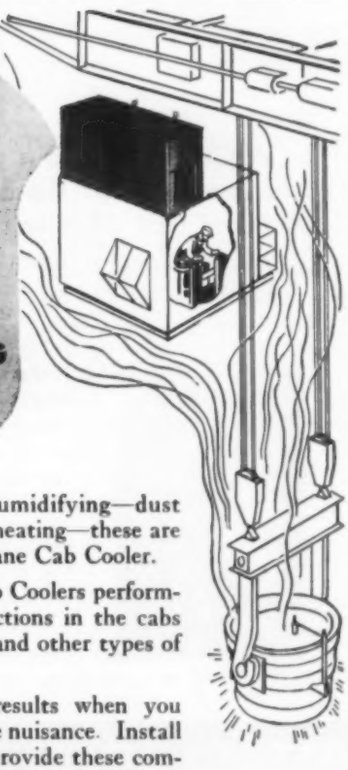

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You will find Dravo Crane Cab Coolers performing these air conditioning functions in the cabs of soaking pit, ladle, stripper, and other types of hot-metal cranes.

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head, is mounted on the outside of the furnace or kilns, away from the hot zone, and picks up radiant energy emitted from the surface of the object under measurement. In this way, actual surface temperature measurements of the work are obtained, rather than the usual furnace atmosphere temperatures. Extremely rapid response is claimed as the outstanding feature of the radiation unit, which is said to produce a 99 per cent response to a temperature change within one second.

OIL-LUBRICATED MOTORS OPERATE IN ANY POSITION

▲ A new line of lifetime oil-lubricated, shaded-pole motors designed for operation in any position — shaft up, down, horizontal, or at any intermediate angle — has been announced by General Electric's fractional horsepower motor divisions.

Designated as Type KSP — frame sizes 11 and 21, the new motors can be used as drives for exhaust fans, cooling fans, evaporative coolers, unit heaters, condenser cooling, and space heaters, as well as for small pumps, agitators, and blowers.

The motors are available in either open or totally enclosed construction. Ratings range from 25 millihorsepower (1/40 hp) through 1/12 hp at 115 or 230 volts, 1050 or 1550 rpm, 60 cycles.

A new lubrication system provides a constant flow of oil from a large reservoir to the bearing surfaces regardless of the position of the motor. Oil-saturated packing continuously feeds the bearing with filtered oil; no additional lubricant is ever required.

Other features include a new unit-bearing construction in the shaft end of the motor for greater strength on direct-connected loads; treated stator windings of Formex (R) insulated wire; and vibration-absorbing resilient end rings which are resistant to oil and aging.

Mounting arrangements for the new motors include resilient end ring mounting, resilient cradle base, and band mounting. Motors also are available with four tapped holes on the shaft end for end mounting.

There are many STEPS to Industrial Waste Control

Federal, State and Municipal Regulations require that you take these steps *NOW!*

AND SAMPLING is one of the most important steps in the process. The Engineering Division of the Pittsburgh Pipe Cleaner Company is using the best type of sampler for quantitive analysis of your industrial waste.

Photo at left shows the refrigeration compartment where samples are held at correct temperature for chemical and toxicity tests.

Photo at right shows electric timing device to operate dipper motor. It may be adjusted to take from one to thirty samples per hour.

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LARGEST DIE BLOCKS FORGED BY HEPPENSTALL

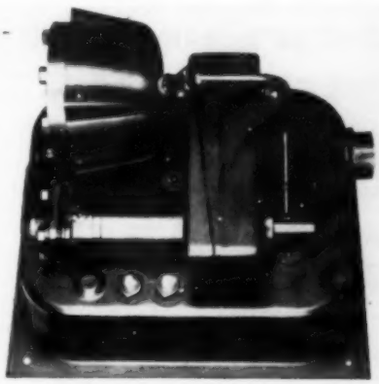
The largest and heaviest die blocks ever to be forged in the Pittsburgh, Pa., plant of Heppenstall Co. are shown above. According to John P. Roche, vice president and general manager of sales, it was most appropriate that these huge blocks of steel were fabricated during the 60th anniversary year of this manufacturer. Each block was 16 in. by 44 in. by 160 in., and weighed 32,100 lb. The picture shows the two die blocks after Wyman-Gordon Products Corp., Worcester, Mass. had cut the desired impressions. Aluminum alloy rounds, 6½ ins. in diameter, were forged to specified dimensions in these huge Heppenstall die blocks.

FLOW METER FEATURES MAGNETIC CLUTCH

▲ Hays Corp. has announced the marketing of a new type of flow meter which features a magnetic clutch to transmit the movement of the float instead of the conventional mechanical arrangements.

The new meter is called the Hays-Penn "Magna-Clutch," being manufactured in the plant of Penn Industrial Instrument Corp., but sold through Hays Corp. nation-wide sales organization.

The magnetic clutch principle is not entirely new. Magnetic clutch flow meters have long been in use in Europe, but their development in this country was hampered by the unavailability of high powered magnets and non-magnetic metal wall material of sufficiently high tensile strength, both of which are now obtainable.



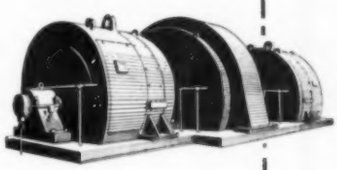
More power with less friction is claimed for the new motor due to its exceptionally large float (3.75 in. in diameter) and long foot travel (1.5 in.). The greatest source of friction and maintenance in any mechanical flow meter is the stuffing box through which movement of the float is transmitted. In the Hays-Penn Magna-Clutch no stuffing box is used. The movement of the float is transmitted through a pressure tight manometer by means of the magnetic clutch. This construction eliminates stuffing box friction, leakage and maintenance, and makes for sustained accuracy.

Five adjustable range tubes give wide rangeability — anywhere from 17 in. to 750 in. water differential. Working pressure is given as 1500 psi and 2500 psi (convertible in the field).

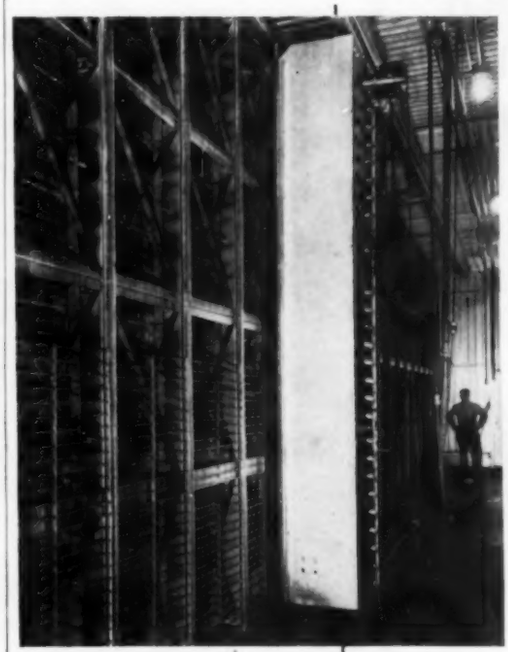
Six types or combinations of recording, indicating and integrating meters are offered. Meters are now in production and deliveries are being made promptly.

Where SUPER-CLEAN AIR for mill motors is a "must"

AAF Electro-Cell combines high cleaning efficiency with ease of maintenance



WHERE conditions permit no compromise in the cleanliness of the air supplied for cooling mill motors, the AAF Electro-Cell is your logical choice. This electronic precipitator gives positive protection against dust and smoke—even down to fractional micron sizes.



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Electro-Cell's sectional construction reduces weight of parts, eliminates multiplicity of electrical connections, protects wiring from dirt and water. And its full-height hinged or removable ionizers minimize electrical losses, reduce ozone and simplify replacement of ionizing wires.

If you want super-clean air plus proven savings in operation and maintenance, get complete Electro-Cell data now. Just contact your local AAF representative or write direct for Bulletin No. 252.

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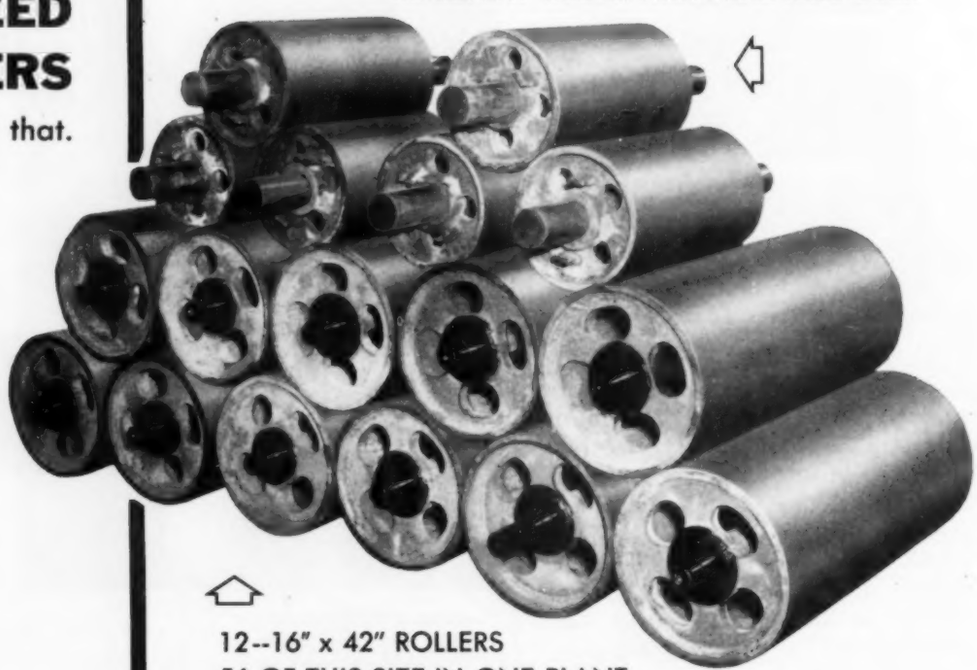

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Book Reviews

▲ NEMA has recently published the following new publications:

"Standards for Helical Reduction Gears for use with Steam Turbines, Publication No. TU1-1949." This new publication deals with single-reduction, double- or single-helical, parallel-shaft, high-speed gears as used with turbines for the transmission of power either as speed-reduction or speed-increasing gear sets. Horsepower ratings, service factors, and features and accessories are a few of the specific standards contained in Publication No. TU1-1949. 8 pages, 8½ × 11, $0.70.

"Standards for Rubber Insulated Building Wire and Cable, 0-5000 Volts, Publication No. RV2-1949." The dimensions, insulation, covering and testing of the following types of rubber insulated building wire and cable comprise the subject matter of this publication: Type R — Code Grade and all Neoprene, Type RH — Heat-resistant Grade, Type RW — Moisture-resistant Grade, and Type RU — Latex Grade. 40 pages, 8½ × 11, $1.25.

"Standards for Thermoplastic Insulated Building Wire and Cable, 0-600 Volts, Publication No. RV1-1949." Publication No. RV1-1949 provides practical information concerning the dimensions, insulation, physical and aging requirements, and testing and electrical requirements of thermoplastic (Type T) and thermoplastic moisture-resistant (Type TW) insulated building wire and cable. 24 pages, 8½ × 11, $0.90.

▲ The results of tests in which steel was produced from sponge iron at the Bureau of Mines pilot plant at Redding, Calif., are given in a recent report.

A part of the Bureau's long-range program aimed at more effective utilization of the country's mineral resources, the tests were designed to evaluate some of the possible advantages offered by the use of sponge iron as a raw material for production of steels over the conventional scrap-and-pig-iron process.

The report describes the melting facilities used at Redding, and describes and gives the analyses of the several types of sponge iron that were used. It also discusses reducing agents, fluxes, and alloys, as well as describing the types of alloys produced and the furnace practice used.

Equations are included for calculating the amount of reducing agent that must be charged with the sponge, and also for the weight of slag formed in melting sponge iron of a given analysis and the increased power requirements for producing steel from sponge iron.

The analyses of the steels produced also are given. The report notes that the work of determining the physical and mechanical properties of the sponge-iron steels is in progress, and the results will be reported when available.

A free copy of Report of Investigations 4498, "Pilot-Plant Production of Steel from Sponge Iron," by W. W. Stephens and J. L. Morning, Bureau metallurgists, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

▲ The fifth edition of "Steel and Its Heat Treatment" Vol. III, Engineering and Special Purpose Steels by D. K. Bullens has just been prepared by the metallurgical staff of the Batelle Memorial Institute. This book correlates present known facts about the more important alloy and special steels and use particularly with respect to heat treatment. The carbon, mild alloy, N. E. S. A. E. and tool steels are covered. An analysis is made of the effect of heat treatment on the suitability of these steels for various uses, as well as the possibilities of using alternate steels. The book is divided into three sections, engineering alloy steels, constructional alloy steels for heat treating, and special steels. An unusually good and complete bibliography is given at the end of every chapter. Publisher of the book is John Wiley and Sons Inc., 440 Fourth Avenue, New York 16, N. Y. Price $7.50, 606 pages, 283 figures, 5⅞ x 9 in., cloth. Induction Heating by N. R. Stansel, just issued, presents the electrical and thermal principles of the use of eddy-currents for heating service and shows how these principles are applied in practice. The examples cover the entire range of practice from heating metal parts at temperatures below the melting point to the melting of metals. The book is primarily fundamental in treatment, and shows the relationship of the electric, magnetic and thermal properties of conductive materials, of frequency, and of the dimensions and shapes of the body to be heated. Supplementing the equations which express these relations are curves which show visually the effect of these factors. Engineers will find this book of practical value in extending their understanding of the technical and economic use of eddy-currents for various heating applications. Books may be obtained from the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. Price, $3.50, 212 pages, cloth, 6 x 9 in.

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AISE Annual Convention

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INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Co. 1
Affiliated Furnace & Engineering, Inc. 122
Air Products, Inc. 160
Air Reduction Sales Co. 154
Alliance Machine Co. 26
Allis-Chalmers Manufacturing Co. 12, 13
American Air Filter Co., Inc. 163
American Chemical Paint Co. 157
American Manganese Steel Division,
American Brake Shoe Co. 140

B

Bachrach Industrial Instrument Co. 148
Badall Engineering & Manufacturing Co. 164
Bantam Bearings Division of
The Torrington Co. 147
Bedford Foundry and Machine Co. 161
Birdsboro Steel Foundry and Machine Co. 40
Bloom Engineering Co. 134
Bonnot Co. 19
Brooks Oil Co. 6
Brown Instrument Division,
Minneapolis-Honeywell Regulator Co. 30
Browning and Co., Inc., Victor R. 146
Buffalo Forge Co. 33
Bussmann Manufacturing Co. 114, 115

C

Clark Controller Co. 127
Cleveland Crane and Engineering Co. 46
Continental Foundry and Machine Co. 35
Crocker-Wheeler Electric Manufacturing Co.,
Division of Elliott Co. 27
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Steam Turbine Co. 142
Documentation & Licenses, Paris, France 50
Dravo Corp. 161
Drever Co., The 50

E

Electric Controller and Manufacturing Co. 9, 143
Electric Service Manufacturing Co. 49

F

Falcon Bronze Co. 148
Farrel-Birmingham Co., Inc. 16
Farval Corp. ..... Cover 3
Flinn & Dreffein Engineering Co. 50
Furnace Engineers, Inc. 18

G

General Electric Co. ..... Cover 4, 14, 15
General Refractories Co. 4, 5

H

Halden Machine Co. 50
Hays Corp., The 156
Heppenstall Co. 139
Heyl & Patterson, Inc. 43
Homestead Valve Manufacturing Co., Inc. 155
Hunt and Son, Inc., C. B. 131
Hyatt Bearings Division,
General Motors Corp. 48
Hydropress, Inc. 3

I

Industrial Gear Manufacturing Co. 146

J

Johns-Manville Corp. 151
Jones Foundry and Machine Co., W. A. 150
Koppers Co., Inc. 10, 158, 159

L

Leeds and Northrup Co. 42
Lewis Foundry and Machine Division,
Blaw-Knox Co. 28
Link-Belt Co. 11
Lintern Corp. 144
Lumnite Division,
Universal Atlas Cement Co. 116

M

Mackintosh-Hemphill Co. 121
Manning, Maxwell and Moore, Inc.,
Shaw-Box Crane and Hoist Division 31
McKay Machine Co., The 50
Medart Co., The 132
Mesta Machine Co. 7
John Miles & Partner (London, Ltd.) 50
Morgan Construction Co. 23
Morgan Engineering Co. 152
Morganite, Inc. 138

N

National Bearing Division,
American Brake Shoe Co. 20
Norma-Hoffmann Bearings Corp. 168

O

Oakite Products, Inc. 148
Ohio Electric Manufacturing Co. 128
Okonite Co., The 2, 161

P

Pennsylvania Transformer Co. 25
Pittsburgh Lectromelt Furnace Corp. 52
Pittsburgh Pipe Cleaner Co. 162
Pittsburgh Rolls Division,
Blaw-Knox Co. 44
Poole Foundry and Machine Co. 36
Post-Glover Electric Co. 22

R

Reliance Electric and Engineering Co. 45
Rockbestos Products Corp. 34
Rust Furnace Co. 111

S

SKF Industries, Inc. 123
Speer Carbon Co. 29
Square D Co. 41
Steel Processing Co. 32
Swindell-Dressler Corp. 130

T

Taylor Chain Co., S. G. 136
Taylor Sons Co., Chas. 24
Torrington Manufacturing Co., The 135
Trabon Engineering Corp. 124
Timken Roller Bearing Co. ..... Cover 1
Treadwell Co., Inc., M. H. 37

U

United Engineering and Foundry Co. 17

V

Vaughn Machinery Co. 8

W

Wagner Electric Corp. 133
Ware Fuse Corp. 161
Wean Engineering Co., Inc., The 50
Wean Engineering Co. of Canada, Limited, The 50
Wean Equipment Corp. 50
Wellman Engineering Co., The 141
Westinghouse Electric Corp. 21, 38, 39

Y

Youngstown Alloy Casting Corp. 149
Youngstown Foundry and Machine Co. 145

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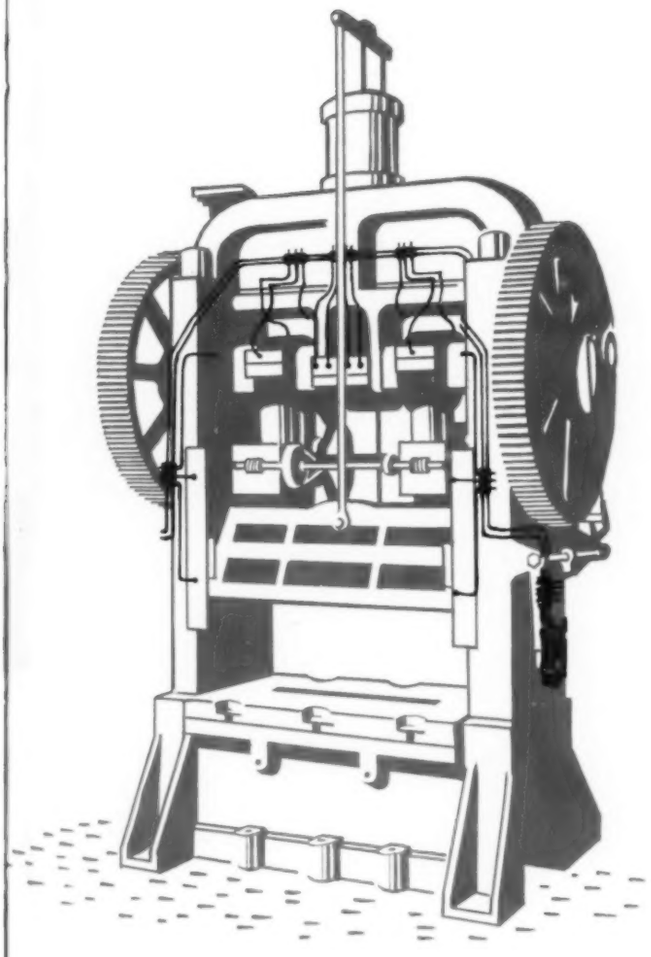

FARVAL—*Studies in Centralized Lubrication No. 93*

IN a metal working plant, lack of proper lubrication always kept a double crank press in trouble. Maintenance alone cost $161.00 in a six-months' period. Many hours of valuable production time, and valuable production, too, were lost while the press was down for repeated repairs.

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For a full description, write for Bulletin No. 25. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

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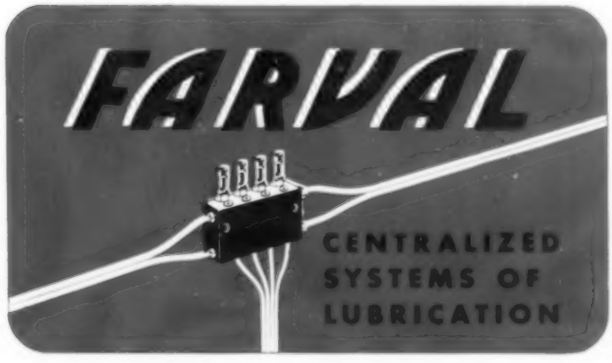

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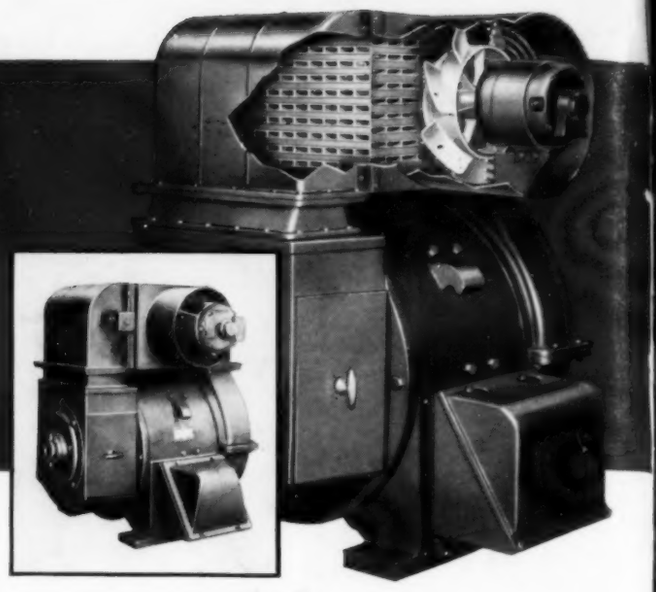

unit-cooled D-C MOTORS

Single-blower type for normal speed operation In this standard G-E motor, the unit cooler consists of alternate air passages placed at right angles to each other. Clean motor air, kept in motion by a fan on the main motor shaft, circulates through one set of passages in an enclosed system. Cool outside air, drawn into the cooler by a blower separately motor-driven, flows through another set of passages and absorbs the heat from the internal air stream. Motor air, never in contact with contaminated outside air, is always clean.

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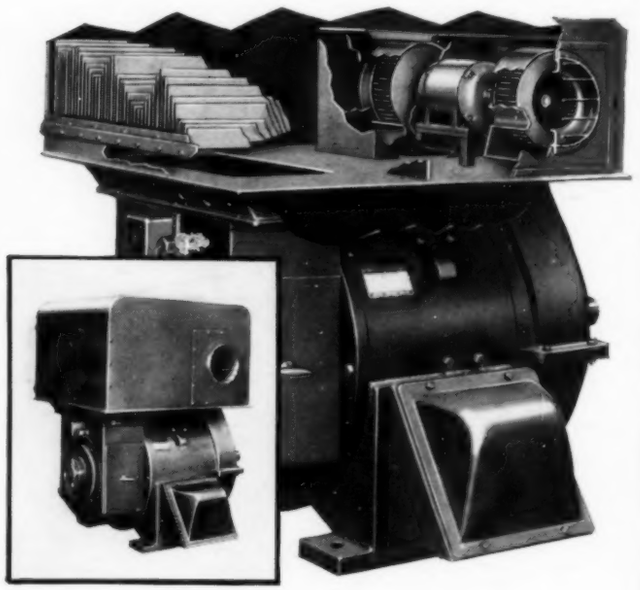
Better protected and better cooled, these tough G-E motors are available in ratings from 15 to 200 hp. See your G-E representative for more information, or write for Bulletin GEA-4469. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



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659-67